Patterns of Rural Development in Tamil Nadu

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Abstract

The thesis examines the question of the processes through which regional contrasts in rural development have operated in the State of Tamil Nadu, South India. It falls into three main parts. In the first two Chapters general theoretical and empirical questions relating to regional problems of rural development are discussed, and the analytical approach adopted in the thesis is introduced. In Chapters Three, Four and Five relevant features of the physical, social and economic environment are examined with reference to their bearing on macro-level patterns of rural development in Tamil Nadu, focussing on the period since India's Independence in 1947. In Chapters Six, Seven and Eight the analytical focus shifts to the study of village level patterns of change with respect to a limited number of agricultural and consumer variables. A sample of villages selected on a stratified random basis from the whole State serves as the data base for an empirical testing of hypotheses relating the spatial processes of change to accessibility. Concepts of accessibility are discussed , several definitions are proposed and the significance of alternative forms of accessibility for the spatial process of development are examined.

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Glossary

This glossary refers to those words underlined in the text.

District	The major administrative sub-division of the State
Harijans	'The children of God' - outcastes.
Karnam	Village accountant
Panchayat	The village council
Panchayat Union	A grouping of village councils, related in Tamil Nadu to Block Development areas.
Patta	A written title to land.
Pattadar	A person who holds a patta.
Ryot	A peasant farmer or cultivator
Ryotwari	The system of tenure in which farmers held land directly from the State.
Taluk	The administrative sub-division of the District.
Varna	'Colour' - referring to the four classical divisions of caste.
Zamindar	Strictly intermediary farmers , often regarded as landowners during the British period.

CHAPTER ONE

Patterns of rural development in Tamil Nadu: the regional problem

1.1 Introduction

Rural development is fundamental to Indian plans for economic growth. Since the inception of formal planning rural improvement has been one facet of the wider aim of achieving growth with social and economic justice. Thus an integral part of all development programmes has been the espousal in theory at least of balanced regional development. Growing out of the village development and de-centralisation philosophy of Gandhi as much as from any particular economic school of thought, successive Plans have had an avowedly egalitarian bias in both regional and sectoral terms.

While the aim of balanced regional growth has been clearly stated, there are apparent differences of interpretation of the regional concept itself. The classic regional study of the South Asian sub-continent by Spate and Learmonth (1968), for example, based its regional classification on the physical character of the landscape. As Sopher (1973) has pointed out, a regionalisation on such a basis may be expected to bear little relationship to one that could be drawn on anthropological lines. Similarly the regional schema developed in the joint Russian-Indian work of Sdasyuk and Sen Gupta (1968) illustrates the extent to which contrasting views of the basis for regional definition can substantially affect analysis. While the distinctively 'regional' approach of these and other geographers (Dupuis 1967) has contributed considerably to the understanding of regional contrasts in economic activity, the problems which such contrasts present have also been approached from quite different angles. Since the early work of Weber (1909) on industrial location geographers and economists have been drawn to the study of systematic spatial variations in economic activity. Such analyses, while having strong regional implications, have not attempted any form of analysis of regions per se but have tried to isolate systematic processes affecting the spatial organisation of economic activity. Perroux (1955) brought some of these concepts of the spatial organisation of economic activity to bear on the problem of regional economic development in his enunciation of growth pole theory. This was followed rapidly by the independent work of Myrdal (1957) and Hirschmann (1958). All these analyses were concerned fundamentally with the question of the spatial organisation of industrial activity in newly developing regions, and focussed particularly on the role played by such factors as economies of scale, concentration and agglomeration. Myrdal's exposition of his theory of circular-cumulative causation was the most explicit examination of the causes of regional backwardness and the failure of equilibrium theory to explain regional contrasts in development.

Although not directly linked with growth pole theory or with Myrdal's concept of circular-cumulative causation, a third general approach to regional economic disparities also appeared in the early 1960's which had much in common with the search for systematic spatial factors and their bearing on regional development. This aspect of research has focussed on the role of accessibility as a spatial factor of major significance in the development process. One aspect of this emphasis has been the increasing attention paid to urban centres as foci of economic and social change (Turner 1960). A separate but nonetheless related aspect has been the analysis of the structure of transport networks and their significance for regional development levels (Taaffe and Gauthier 1973). Studies in this field have emphasised the need for a refinement of the techniques of measurement in order that the precise role of various forms of accessibility may be assessed. Again, such studies have not attempted to take into account those features of the regional environment regarded as the traditional subject matter of geographical analysis, and yet their approach has clear implications for the general understanding of regional contrasts in development achievement.

The diversity of method shown by these three approaches to the question of contrasts in regional economic development does not conceal the apparent fact that substantive differences in economic performance exist in many parts of the world. That such differences exist in India is suggested by the continued reference in official Government plans to the need to eliminate or ameliorate them. Both the inequalities and some of the efforts to combat them antedate Independence in 1947. However, despite the impressive scale of some of the development projects embarked on from the latter part of the nineteenth century, the efforts to remove backwardness had been in general piecemeal and spasmodic. In the prevailing economic and political climate , in which Central Government took little direct part in fundamental economic matters, and where in addition to the areas under direct British rule there were over 600 princely States, little else could be expected.

The early gazetteers of the nineteenth century testified to the variety of language, culture, economy and society found within the sub-continent. Contrasts between the major regions in terms of climate, soils, relief and vegetation were pronounced. At the local level, District Collectors testified to the complexity of village life, the diversity of tribal, village and caste custom, and the fine adaptations of village communities to local environmental and ecological conditions. This diversity contained within it the seeds of economic disparity.

The achievement of political independence in 1947 released new energies whose immediate focus was the rapid generation of economic growth. Such growth was seen by many in the Indian Government as an essential pre-requisite of true political independence. It was also seen as the vital stepping-stone to the abolition of poverty and the establishment of a socialist state in which wealth could be equally shared by all. The drive for growth was intended to bring both prosperity and equality, and in all the Plans this equality was seen as having both social and regional dimensions. In practice several changes in policy have occurred since the aim of balanced regional growth was first espoused. Thus in the industrial context the chief aim of the Industrial Estates Policy, adopted in the Congress Resolution of 1956, was the encouragement of rural industry. As Alexander (1963) showed however the majority of the successful estates were located in large towns or cities. Through the 1960's lip-service continued to be paid to de-centralising industry through the development of industrial estates, but most expansion was in the metropolitan areas.

Policy with respect to agriculture also underwent changes between the adoption of the First Five Year Plan (1951-1956) and 1971. The early planning period was marked not just by an emphasis on growth in output, shown particularly in the stress laid on the expansion of irrigation facilities, but by a corresponding emphasis on building the rural infrastructure for development. This was to be achieved both through a radical alteration of the land ownership systems and through the training of the rural peasantry in the use of new agricultural technology. Coupled with the aim of widespread rural 'modernisation' this training was to be achieved through the implementation of the Community Development Programme. As Mellor (1972) has pointed out, the successes of the First Plan in the abolition of zamindars did not remove all cause for concern over prevailing land tenure systems. Nor was co-operative farming proving to be a success. The democratic decentralisation which the Community Development Programme was aimed to achieve ran into early difficulties, and during the Second Five Year Plan (1956-1961) agricultural production stopped rising. Failure to meet predicted growth targets caused increasing uncertainty, and in 1961 a pronounced shift in Government policy occurred with the adoption of the Intensive Agricultural Districts Programme.

This shift represented more than simply the adoption of a new strategy for achieving production targets. It represented also a move away from a policy of balanced regional growth within agriculture , although it was not explicitly acknowledged as such. The new package programme was characterised by four main features (Mellor 1972).

1. It aimed at increasing production directly rather than through improving the general context

for development.

2. It deliberately chose those areas estimated to have a high potential for development, thus making concepts of egalitarianism subject to the imperious call for increased output.

3. Emphasis was shifted to the profitability of the individual farm.

4. Special emphasis was placed on the provision and use of new inputs, the most important of which was chemical fertiliser.

A number of points at which the package programme failed can be identified, but these are not relevant in the present context. The important feature of the programme from the point of view of its impact on regional growth and development lies in its emphasis on already relatively prosperous districts at the expense of relatively backward ones. It is clearly indisputable that the gap between the relatively rich and the relatively poor regions could only be widened by such a policy. Only in Fourth Plan (1969-1974) was renewed consideration given to the condition of the most backward districts through the attempt to define backward regions in each State with a view to drawing up special development plans aimed at their improvement. Even then it was not until 1971 that the lists of backward districts were drawn up, and the selection of districts was made on the most rudimentary basis.

Despite increasing interest in the theoretical aspects of regional development evinced in the work of Perroux, Myrdal and Hirschmann, there remained remarkably little analysis of the spatial processes of change in India, or of the success or failure of Government policies of balanced regional development. Such analyses as were presented during the late 1950's and 1960's suggested that the evidence itself was conflicting. On the one hand there was the view of the Planning Commission's Programme Evaluation Organisation (1967) that regional disparities within India were decreasing. Taking a number of different indices relating to such aspects as agriculture, education, health, consumption, rural investment and rural debt, they computed an index of regional variation both between States and within regions of the State.[1] The index used was a form of the standard deviation for each indicator. Unfortunately the number of regions was extremely small. Tamil Nadu, for example, was divided into only two regions. Apart from the statistical problems of calculating standard deviations based on only two observations, the problem also arises that the basis of the regions (chosen by the National Sample Survey for other purposes) did not conform in any rigorous way to the principle of minimising internal differences and maximising differences between regions (Berry 1961). Hence the finding that regional variations in levels of living within Tamil Nadu fell over nearly the whole range of indices do not carry as much weight as might otherwise be the case.

In contrast to this view of decreasing regional disparities in wealth the proceedings of the Patna conference (1969) recorded a strong impression of growing disparities, and papers by Chakravarty (1969) and Williamson (1964) lend weight to this view.

1.

The index was computed from the formula

$$I = \frac{\sqrt{\frac{(Ri - S)^2}{n}}}{S}$$

Where I = the index of variation, Ri = the indicator for the region, S = the value of the indicator for the State and n = the number of regions.

The evidence remains unclear for a variety of reasons. One of the most important is that the scale at which analyses have been carried out has varied . As Haggett (1964) has argued, findings applicable at one scale may be irrelevant or misleading at another. Much of the analysis of regional variations in development in India has been concerned with State level variations. While this may be appropriate for macro-level analyses within India as a whole it has to be remembered that some Indian States are larger than many European countries. It is at the lower levels of contrasting regional development performance that analysis remains very inadequate.

1.2 Tamil Nadu as the Region for Study

From both a theoretical and from a practical point of view Tamil Nadu has points which strongly recommended it as an area for the study of intra-State patterns of regional development in 1971. By 1971 it had emerged as a State with one of the most rapidly growing economies in India. It had inherited a highly efficient administration, and was poised for a major development effort in 1947. During the Planning period it underwent a process of relatively rapid change in terms both of direct Government activity in the economic sphere and of legislative reform designed to bring significant change to agricultural activity. Although it only represented the rump of the former Madras Presidency when the re-organisation of the States took place in 1956, it was one of the most urbanised States in India with one of the best developed and most integrated urban systems. Within its borders it had very considerable environmental diversity, which was paralleled by a wide diversity of cropping patterns and of land tenure arrangements. The extensive practice of irrigation using traditional methods had been enhanced by large-scale and small-scale developments, and by the pioneering of new irrigation and agricultural technology. Furthermore, by the end of the 1960's Tamil Nadu was one of the very few major rice growing areas in India to have experienced rapid agricultural improvement associated with the "green revolution", and many villages were showing signs of becoming integrated with the wider economy. All these factors had led to Tamil Nadu becoming what could well be termed an "Intensive Academic State", and a favoured research area not only for geographers (Farmer et al. 1974) but for anthropologists, political scientists and economists alike.[1] However, there were additional factors which made it particularly suitable for the present study. With a highly developed road and rail network it had perhaps the most highly interconnected transport system in India, making it possible to examine in detail the role of accessibility in the development of regional contrasts in economic change.

1.3 The Aims of the Thesis

Within the broad general theme of regional development this thesis is addressed particularly to the questions posed by regional patterns of change at the village level. The fundamental questions relate to the role and importance of environmental, economic and administrative factors in the shaping of the broad regional patterns of change. It is within the context of these broad patterns of change that the village level patterns of change can then be analysed, and the nature and pace of village level changes in agriculture and in patterns of consumer goods adoption is examined against this background.

1. The relevant literature is referenced in subsequent Chapters.

The subsequent analysis falls into three parts. First , there follows in the next Chapter a detailed outline of the analytical procedures followed in the thesis. The second major section (Chapters Three, Four and Five) presents an analysis of the physical, capital and administrative sub-systems within Tamil Nadu, and of their bearing on regional patterns of development. Thirdly the analysis moves on to examine the specific role of accessibility as a systematic spatial factor in the process of regional differentiation. In conclusion, an attempt is made to relate the regional factors to what may be termed the systematic spatial factors and to assess their relative importance.

CHAPTER TWO

The Analytical Approach

2.1 Introduction

The complexity and interrelatedness of the development process makes any attempt to analyse limited aspects of the whole open to distortion. Yet such a partial analysis is essential if any depth is to be reached or if specific hypotheses are to be tested.

This Chapter outlines the chief characteristics of the approach followed in this thesis. After a discussion of the importance of scale of analysis, which has an important bearing on the nature of the analytical processes adopted, the concept of regional accessibility with which the thesis is fundamentally concerned is outlined. The importance of environmental considerations is then examined, and this is then placed in the context of the village level approach to regional development analysis. This is followed by a discussion of the primary and secondary data sources and of the sampling framework for the primary data collection in the field. This in turn leads into a discussion of the practical problems of data collection and of the structure and implementation of the field survey questionnaire.

2.2 Scale

As Haggett (1965) has argued, the scale at which a problem is studied has a fundamental effect both on the appropriateness of the methods to be adopted and on the nature of the results obtained. This study focuses on the regional and spatial patterns of development at the village level. While it is essential to place any village study in the wider demographic, geographical and economic perspective of the State as a whole, in this study no analysis is made of what economists for example would regard as staple fare - investment patterns, budgetary and financial policy, capital-output ratios and the like. In contrast to these 'macro-economic' factors, attention is focussed on the nature and patterns of change at a village level. Furthermore, the study is concerned with changes which have occurred in a very narrow time span of the recent past, leading up to 1971. Such an analysis rules out from the discussion several factors that are important to more general aspects of the development question.

In focussing attention on the regional patterns of development it is necessary to explore the relationship between such patterns and the nature of the regional resource endowment. At this point also the question of scale arises. In its area of 55,000 sq. miles (130,069 sq.kilometres) Tamil Nadu has thirteen districts in addition to the metropolitan district of Madras, and over 130 taluks . Not only does the level of generalisation differ significantly according to the size of the areal unit being studied, but the characteristics of the resource base relevant to the study also vary. Thus , while a general understanding of the wider regional resource pattern is indispensable , local variations in , for example, soil, rainfall and relief, are more likely to be of critical importance than are the distribution of iron ore or coal deposits.

2.3 Accessibility and Regional Development

Common sense suggests that accessibility may be a key factor in the rapidity with which villages accept new techniques of agricultural production. Remote villages clearly have to overcome many disadvantages before they can participate in the market economy through which are mediated the social, technical and economic means of development. The advantages of centrality have been the object of increasing theoretical and empirical study. Myrdal's (1957) hypothesis that circular-cumulative causation was the principal process of regional development, and Perroux's (1955) growth pole concept both attempt to account for increasing regional disparities in economic performance. In both models distance is isolated as a crucial factor retarding development, the major urban centres being regarded as the focal nuclei of the dynamic economy and the remote rural areas as the retarded regions. Empirical studies such as that of Owen (1968) have attempted to demonstrate the importance of good communications to the achievement of national development targets. Mellor et al. (1972) examined specifically the role of transport in Indian agricultural change, and Johnson's (1970) work on markets and development in India also assumes the importance of good transport.

Despite the evidently widespread assumption that there is a strong relationship between communications and development, it is an assumption that remains largely untested. At least in part this is a reflection of the absence of refined measures of accessibility.

One of the fruits of recent research has been the increasing sensitivity of measures of accessibility. This development has led to a widening of the scope of research on questions relating to accessibility and economic change. Two contrasting concepts may be distinguished.

1. Specific Accessibility. This concept relates the accessibility of any one particular place to any other place within a region. Although in essence it is a very simple concept in practice it may be measured in a number of different ways. Straight-line distance, time, cost and route distance are examples of indices of specific accessibility which have been used.

2. Generalised accessibility. In contrast to measures of specific accessibility to individual places, generalised measures of accessibility attempt to summarise the characteristics of accessibility throughout an area. One such group of indices is that related to the concept of population potential, which has now been widely applied in a variety of contexts. Chapman (1973) and Chapman and Wanmali (1976) have attempted to relate patterns of economic development in India to different measures of population potential. On the basis of the argument that it is through urban centres that economic and social change is most rapidly brought about, and that hence high accessibility to urban population is likely to favour rapid change, it is argued that population potential analysis and the study of changes in the urban population potential through time is of considerable diagnostic value.

Although accessibility to the total population or to the urban population may be thought to be a significant factor in the development process, it can also be argued that accessibility is rarely 'general' in the sense of access to the total population, but is nearly always channelled. According to this view it is accessibility to the transport channels and the structure of the network of these channels that is both an index of development and the significant factor in the process of regional economic development. Kansky (1963) has attempted to demonstrate a relationship between efficiency of the network structure and the economic characteristics of a country or region. His topological approach, based on the earlier work of Shimbel (1953), has been widely taken up by workers researching in the field of network systems and their relationship to development (Haggett 1965, Haggett and Chorley 1969, Hay 1973 and Taaffe and Gauthier 1974).

Both 'generalised' accessibility measures present problems when applied to the central theme of the present study. On the one hand population potential and related measures are based on data at a relatively high level of aggregation . In India this has usually been the district (Berry 1967b) or the tehsil and taluk (Chapman 1973). There are both theoretical and empirical problems in applying the technique at the village level . When the village is the focus of study , for example, what is the appropriate level of aggregation at which potential analysis should be carried out ? How wide a region should be incorporated in the analysis ? Should it be restricted just to the State in which the villages lie ? Or should it be restricted still further to the district or taluk ? While it could be argued that it would be desirable to do all three, the theoretical relationship between population potential and village - level patterns of change is far from clearly established.

Analysis of the structure of transport networks in South India is also hampered by theoretical and empirical problems. The chief theoretical difficulty lies in the role of the channels of communication and the importance of different modes of transport and communication at the village level. The 'organised' transport sector still accounts for a relatively small part of the total commodity and personnel movements in Tamil Nadu. Although most of the intermediate and long distance movement now takes place along and through the 'formal channels' , that is the roads and railways, an immeasurable volume of movement still takes place through the 'informal network' of village tracks and footpaths. Analysis of the 'formal' network system is bound therefore to be of limited and somewhat unstable value in analysing regional patterns of village level economic change and development.

There are also severe empirical constraints in carrying out an analysis of the network structure in Tamil Nadu in a way which is relevant to village studies. The absence of large-scale maps makes plotting of routes at the local level difficult or impossible. As Chorley and Haggett (1969) have commented, the stream ordering of a river basin may reflect the accuracy of available maps as much as the objective criteria used in the classification. The analysis of networks of transportation in South India reflect similar uncertainties. Despite these problems , the very significant increase in the accessibility of villages to the formal transport system since Independence in 1947 has brought most villages into the orbit of inter-city communications, even where such communications still play only a minor role. Thus the analysis of the 'formal' transport networks may still be expected to shed light on the relative accessibility of different regions within Tamil Nadu. The role played by accessibility to the transport networks in the regional patterns of development may then be analysed. Despite the limitations of the approach , analysis of the transport systems would make an important contribution to the interpretation of accessibility as a factor in regional economic change.

2.4 The environment and regional development

As the focus of this study is the question of regional patterns of development at the village level, agriculture and the factors which affect agricultural change are of major significance. This is not to say that industry or non-agricultural matters are unimportant. It is simply to recognise that in what is in any event a predominantly agricultural region the study of village level patterns of change inevitably increases the weight placed on agriculture's role. Thus in this analysis the urban centres and their economic characteristics are taken as given, and no attempt is made to analyse the factors which affect their own patterns of development.

With this point in mind it is clear that the character of the resource endowment may be expected to play an important part in the nature and pace of economic change in the villages. In the next chapter the most significant of these physical characteristics are examined, and their bearing on regional contrasts in development performance analysed.

It is clear from what has been said above that only a narrow range of questions is asked in this study relevant to the enormously wide field of economic development and change. Despite their limited scope and the difficulties of treating only one small part of an integrated whole, an understanding of the problems involved would make an important contribution to our understanding of some of the wider issues. Just as it is impossible to divorce the question of economic growth from its relationship to the geographical environment in which that growth is taking place, so it is also essential to analyse the relevant aspects of the man-made environment and their impact on the resource potential of the regions. Tamil Nadu has some of the most developed regions - industrially and agriculturally - in India today. Despite attempts to implement an eqalitarian economic policy since the early 1950's it also has some of the most backward districts. An understanding of the resource endowment on the one hand and of the role of accessibility to natural and man-made resources on the other is essential to the interpretation of regional development contrasts within the State. This is the chief focus of the present study.

2.5 The village level approach

In their analysis of the methodology of village-level studies Lipton and Moore (1972) have pointed to the wide variety of studies carried out under that name. As they argue very forcefully, there should be a clear understanding of the particular purpose underlying village studies, and an explicit rationale for the procedures adopted.

In the subsequent analysis village level data are used for two purposes. First, they are used to provide evidence as to the general character of change in the villages of Tamil Nadu. Secondly, they are used to test specific hypotheses relating to the importance of accessibility and the character of developmental change within the village context. For this latter purpose it was necessary to obtain data relating to the economic and social character of the village, particularly those having a bearing on agriculture.

2.6 Data sources

Any study of regional geography in South India has a rich source of secondary material in official reports and census data , as well as a very large number of village studies, a mode of description and analysis which has been in vogue since the nineteenth century. However, despite the relative abundance of data contained in these secondary sources very little of this material is directly useful for the kind of analysis carried out in this thesis, and it proved necessary to collect most of the data for this study in the field.

The decision to collect primary material does not carry with it any guarantee of reliability or accuracy, and several constraints affect the scope and nature of the material sought. In gathering the data for the analysis presented below the chief constraint on data collection was that of resources, most notably time. The data survey had to operate within the limits of implementation by one person, although considerable support of various kinds was received in the field. This effectively determined the scope and nature of questions, and any form of questionnaire used had to be extremely economical. This gave space only for essential questions directly relevant to the hypotheses being tested.[1]

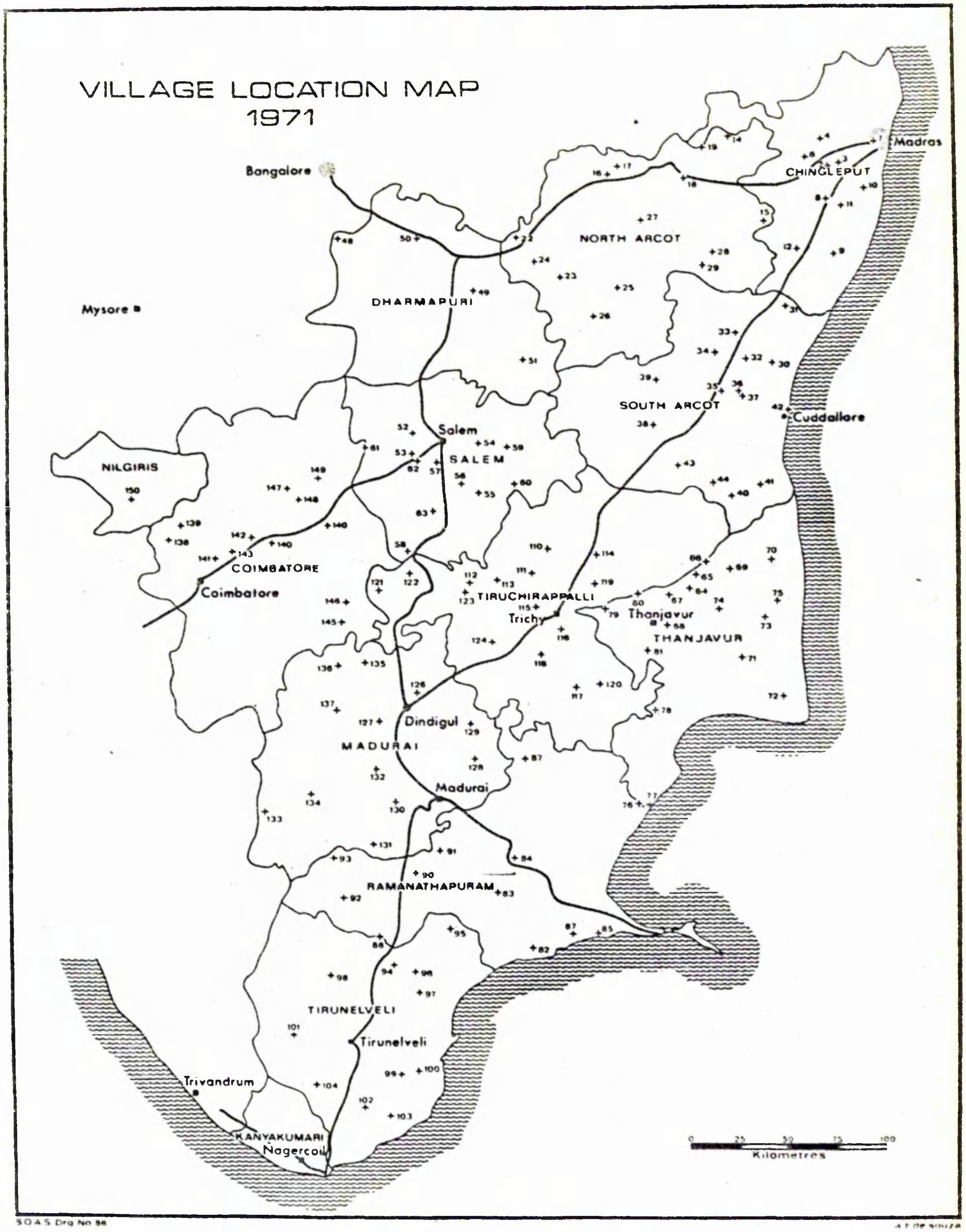
1. That this should be regarded as a constraint may seem distinctly odd . However, many questionnaires are simply devices for collecting as much information as possible , irrespective of the possible uses to which the data may be put.

In view of the constraints much potentially valuable information had to be ignored. Furthermore, some important elements of the structure of village communities was not amenable to the form of analysis adopted. Caste, land ownership, labour inputs, income and many other variables were not investigated in the field in any way. Clearly the absence of such information imposes considerable restrictions on the nature and extent of the conclusions which can be reached. As Lipton and Moore (1972) argue, the economic and social structures of village life (and hence of patterns of change within village life) are characterised by the complexity of their interrelationships. It is recognised that to ignore some of the variables or to focus on only a few of them may distort the picture that develops just as a faulty camera lens may produce distorted photographs. It is important to stress therefore that the data from the primary questionnaire which is the basis of much of the subsequent analysis are used entirely in a restricted way. No attempt is made to analyse more than a very limited range of hypotheses relevant to spatial and regional patterns of development.

2.7 The sample of villages

In order to test spatial and regional hypotheses of the kind advanced in this thesis it was necessary to have a sample of villages drawn from the entire region, and representing the sub-regions and districts of the major region. Furthermore, if use was to be made of the available secondary data to supplement that collected in the field it was necessary that the villages selected should have been studied by other workers sufficiently recently and on a large enough scale to produce comparable material. The first obvious source of such data is the Census of India. In 1961 the Census

Figure 2.1 Village location map: sample villages



For explanation see following pages

carried out large numbers of village surveys to supplement the statistical material of the Census reports themselves. Such reports published in the District Census Handbooks (Census of India 1961 and 1971) are themselves invaluable, but the village surveys are far less useful from the point of view of this study. Lipton and Moore for example show the evident bias in favour of accessible villages which is demonstrated in their initial selection. Thus the mean distance from a road of the Census sample villages was less than four miles (seven kilometres) and over one third of the villages was actually on a main road. Such a bias in favour of accessible villages, though understandable in terms of the constraints of data collection under which the Census was operating, largely invalidates any analysis of accessibility itself as a factor in development. Furthermore, the sampling criteria were not explicitly stated . Thus in addition to the spatial bias already pointed out other hidden biases could easily be introduced into the survey. By its nature such bias could not be measured or accounted for. For these reasons the sample of villages studied by the Census in 1961 did not provide an adequate base from which to explore the hypotheses being tested in this study.

In addition to the village surveys carried out by the Census of India in Tamil Nadu, there have also been several detailed village surveys carried out by other organisations and by individual scholars. These go back to the pioneering work of Gilbert Slater (1918), work which was followed up by a number of his students and more recently by other scholars (e.g. Baden-Powell 1896 , Haswell 1967, Harriss et al 1974) . Despite the value of these studies, from the viewpoint of statistical analysis they suffer from the same shortcomings as the Census monographs, as well as from the additional disadvantage that many of them are now very old. The statistical material, though of interest from a comparative point of view , is of no use as supplementary material to that collected in the field in 1971. In 1971 there was one major source of statistical material which had still been largely untapped, and that was in the records of the National Sample Survey. Since the early 1950's a new round of sample statistical surveys had been undertaken annually. By 1971 the 23rd Round was under way. The data collected related to a range of variables relevant to the village economy, and were collected from a total sample from within Tamil Nadu alone of 624 villages. The sample itself was a stratified random sample (National Sample Survey 1971) , taken from every district of the State. Thus it seemed appropriate to select the villages to be studied from this larger random sample so that where possible data from the National Sample Survey could also be used.

In the event use of the National Sample Survey data proved very difficult. However, the decision to use the 23rd Round of the National Sample Survey as the base from which to draw the random sample for the present study had certain other benefits which are outlined below. The sample of villages was drawn by random numbers from the list of villages surveyed in the 23rd Round. The original sample size was 150 villages giving on average 12 villages in each district. Exceptions to this were the small districts of Nilgiris and Kanyakumari and the metropolitan district of Madras. It can be seen from Figure 2.1 that the villages were widely scattered. The villages were all visited in a six month period from February 1971. This was at the end of the main harvest in the paddy growing areas as well as being a relatively slack period in most of the dry farming areas. The discomfort of working through the hot season was never intolerable, and the advantages both of being able to reach villages in the dry season and of finding villagers to talk to on arrival far outweighed the disadvantages of heat.

The approach in the field was straightforward. A short questionnaire was prepared in Madras and discussed with Government officials and officials of the Tamil Nadu Statistical Office. The questionnaire, which was prepared both in Tamil and English, was tested in two villages in Chingleput District some forty miles from Madras. After discussion with experienced officers of the Statistical Organisation the questionnaire assumed its final form (Appendix 1).

2.8. Data collection

When the villages had been selected the officers in charge of data collection for the National Sample Survey were given an outline of the programme, copies of thequestionnaire and the intended date of my visit. In each district I was then accompanied by statistical inspectors who were already familiar with the villages visited. This assistance was invaluable, for all the inspectors were local men who had visited the villages within the last two years. This had the practical advantage of my being able to find even remote villages relatively easily. In many cases it was also a considerable advantage to have experienced interviewers present, and their help undoubtedly contributed to the accuracy of the responses.

The visits to the villages were of necessity brief, rarely lasting more than half a day. The survey was only feasible because a Land-Rover was available, making it possible to reach even the remotest village. The question of the minimum time necessary to collect va: d information in Indian villages has been the subject of considerable debate. Lipton and Moore (1972) argue that the understanding of village life by the interviewer takes the form of an S shaped curve, and that " at least two or three weeks should be allowed to elapse before major interviewing commences ". They acknowledge, however, that the time required will vary according to the nature of the questions asked, the experience and knowledge of the interviewer and the overall purpose of the survey. Thus their conclusion that two or three months should be spent in villages to produce reports such as those of the Agro-Economic Research Centres is related to the needs of a deep analysis of individual villages. It is clear that for the purposes of this study this was both unnecessary and impracticable. It was unnecessary because the data required were largely non-controversial, and were not subject to major systematic bias.

One further point can be made concerning the process of data collection. The information was collected from what some writers have called ' key informants ' (Harriss et al. 1974). Almost without exception this information was collected in the presence of many other villagers. It was essential to give some prior warning that I would be visiting the village so that wherever possible the village karnam and the village headman could be present. Chambers (1974) has pointed to the dangers of what he called the ' garland syndrome '. He writes that " one of the worst disasters that can befall the tourist researcher is to have news of his visit go before him through some official channel ... so that on his arrival he is greeted by a committee of welcome. He will be treated to selected and censored information anyway..." . Despite these dangers and the undoubted warmth and hospitality of the villagers it was only on very rare occasions that there was any cause for doubt about the veracity of the replies to the questionnaire. Although such an estimate is inevitably subjective, such checks as were possible tended to confirm the evidence given. Walking round the village and the farm fields, and the experience of the statistical inspectors who accompanied gave considerable support to the validity of the answers given. Furthermore it was always established that there was no Government interest in the questions being asked. Almost uniformly it was found that the gains through having forewarned the villagers considerably outweighed the losses that would have been inevitable had no such advance warning been given.

Meetings were held at all times of day, and sometimes late into the night. This runs counter to the belief of Lipton, who suggests that " given the best will in the world there are very few interviewers who would be prepared to travel to and from the villages in lesser developed countries late into the night". I found that statistical inspectors in Tamil Nadu were often prepared to work until very late when it was obvious that the villagers themselves were happy to go ahead. Any concept of the nine-to-five routine is of course completely alien, and frequently it was found necessary to adapt to timings that suited local convenience rather than to impose a foreign diurnal rhythm. Nonetheless , this was only possible because I was directly involved in all of the survey work myself and had the necessary transport

Two points should be stressed concerning the nature of the sample of villages and the method of implementing the survey. First, this study attempts to break new ground b using data collected from a stratified random sample of villages by one person according to a uniform plan and in standardised form. It also breaks new ground in attempting to relate these data to other secondary data, particularly the data collected by the National Sample Survey. The importance of making an attempt of this sort has been indicated by much of the recent literature in this field, which has highlighted the shortcomings of the village level data currently available. Dasgupta's recent attempts to use the data collected by the Agro-Economic Research Centres for 126 Indian villages illustrate very clearly the difficulty of coming to any valid conclusions on the basis of such data.

The second point concerns the importance of field work and of visiting the areas of study. One of the points which emerges from the present study is the wide variation in economic activity found in the different regions of Tamil Nadu. To generalise on the basis of a sample - random or otherwise - for which the data are aggregated as if they were representative of the entire region is a perilous activity. In running the risk of distorting the relationships between man and land such generalisations are also likely to conceal important factors related to economic change within villages. The dangers of such generalisation are clear from Dasgupta's own attempt to produce a typology of village socio-economic systems (Dasgupta 1975). In his study Dasgupta took the data for 126 villages surveyed by the AERC's, processed them by principal components and discriminant analysis, and concluded that it was possible to distinguish three fundamental types of Indian village. While acknowledging some forms of bias in the villages surveyed (proximity to roads and to large towns for example) Dasgupta did not

comment on the regional variations in representation. In his analysis the whole of South India is represented by only fifteen villages. Kerala was represented by two villages, Mysore by only one. To come to any valid conclusions on such a basis involves a feat of legerdemain. To go on to suggest, as he does, that "this one country quantitative study suggests conclusions which might also be generalised for almost all south and south-east Asian countries (excluding Vietnam, of course) where the land-man ratio is low."
goes far beyond the strength even of such powerful statistical techniques as he employs.

While the approach adopted in this study makes possible the testing of specific hypotheses, it is not possible to extend the conclusions to more general characteristics of village social or economic structures. The work of Epstein (1957,1973) and the recent work of Harriss (1974) illustrate the virtues of what some have called the 'anthropological approach' to village studies. In Tamil Nadu itself there have been several such village studies, some attempting to assess the degree of economic change by means of a sequential study of the same villages through time. Haswell (1967) for example attempted to follow up the work of Slater in five Thanjavur villages, studied by him nearly fifty years previously. Unfortunately her study suffered from the defects of both the wide-ranging questionnaire survey method (lack of intimacy with the individual villages, with the consequent dangers of misunderstanding and misinformation) and the anthropological approach (lack of either representative cover or of a statistically sound sampling base). Thus the villages studied by Haswell provide an extremely inadequate laboratory

(as she herself acknowledges) for testing hypotheses relating to regional variations in economic development and change.

2.9 The field survey questionnaire

By the standards of some questionnaires which have been used in Indian villages during the past the structure of the questionnaire was simple and straightforward. Although none of the questions was judged to be sensitive and therefore open to deliberate falsification, some of the questions asked were difficult to answer precisely. Some of the answers were correspondingly difficult to check. The questionnaire was structured so that the simplest and most readily verifiable questions were asked first. This enabled the interview to get under way readily and established a relationship with the respondents. As the interview progressed more difficult questions were introduced with the section relating to agricultural change being left until last. In all, the interviews generally lasted about one hour.

The first group of questions relate to the accessibility of the village. The answers to some of these questions are verifiable from the Census and from large scale maps.[1] Most of the questions in this group were self explanatory and unambiguous. This was not true for the question "distance to the most used *shandy* ". Although the *shandies* or weekly markets often play an important role in village life and in the village economy, Harriss (1974)

1. The answer to the question distance to nearest town was often unknown to the interviewee, and thus maps were often the only source of this information. This was almost universally true of the largest cities.

and Parvati (1975) have shown how complex the relationship often is between villages and the markets. It is very difficult if not impossible to ascertain the most important markets for some villages as they use different markets for specific purposes, sometimes on a seasonal basis. This is particularly true of the large cattle markets, of which there are several that are known throughout the State but which may only be held once or twice a year. Despite these complications a basic structure of local markets through which lowest order goods are bought and sold is widely established. In this questionnaire it was explained that the question relating to the most important shandy referred to the most commonly visited shandy on a regular basis.

The response to the question relating to the number of buses per day was readily verified, but the response to the question about the number of travellers from the village every day was no more than an estimate. It was felt worthwhile to include this question even though the results were not open to precise checking, for the volume of movement between villages and towns is clearly an important variable relevant to several aspects of the village economy. In all of the villages except the largest ones this kind of information is generally well known. In some cases the bulk of the daily movement from villages is by bus or occasionally by rail. Villages within the orbit of Madras for example frequently have a large commuting population. However, it was also made explicit that the answer should include those who had work outside the village but went on foot. It is an indication of the increasing accessibility to roads that few of the villages were completely beyond the reach of a bus service.

The next section of the questionnaire attempted to ascertain the degree of involvement of the villages' farms with the market. Questions relating to the proportion of the total crop sent to market are subject to considerable distortion and error from several sources. These may be summarised under three heads.

1. Ignorance. It is clearly very difficult for village leaders to know precisely what proportion of the agricultural output of the village is sent to market. Knowledge reflects the size of the village, and the degree of land ownership and tenancy. In many villages , however, it was clear that respondents had a clear idea of the surplus which was marketed.

2. Deliberate falsifiaction. In one visit in Salem District it was clear that one of the respondents feared to respond truthfully to these questions as he expected Government action on procurement of crops to follow very rapidly! It was interesting to see how strongly the other villagers present reacted to his unwillingness to give accurate information. As has been made clear above it is impossible to check the reliability of the response, but apart from this one case it was my experience that there was a remarkable willingness to attempt to give correct information.

3. Yearly and seasonal variation. This is by far the most difficult factor to take into account. Most of the unirrigated areas in Tamil Nadu grow only one crop per annum. It is therefore relatively easy to say what proportion of the previous season's crop was sold in the market. Irrigated land however is commonly double or even triple cropped. The proportion of each crop which is sold varies not only according to the season but also from region to region. Thus in Thanjavur the Kuruvai crop is harvested in the rainy season when the keeping properties of the rice are very poor. The bulk of the crop

is sold as soon as possible. The *samba* crop on the other hand is generally of a far higher quality and is often kept for long periods, either for consumption or for sale when the market price is high. This fact in turn adds to the complications of data reliability and comparability.

Despite these difficulties the responses do give a reasonable estimate of the degree of interaction with the market. These data, along with those relating to the methods of transporting goods to market are not the focus of interest in this study but are used as control variables in the subsequent analysis. For this reason the relative degree of interaction shown by each village is more important than the absolute figures, and there is no reason to suggest that such relative positions are misrepresented.

The next section of the questionnaire was devoted to changes which had taken place in the village in terms of technological and consumer innovations. The answers to all these questions were generally reliable. There was no reason for systematic evasion or distortion and generally the numbers involved were small.

This led into the central group of questions concerning the changes of particular relevance to agriculture. The number of farmers using new strains of seed, expenditure on chemical fertilisers and the proportion of the area of different classes of land sown to high yielding varieties of seed were all discussed. Figures relating to the percentage of land that had some form of irrigation were particularly interesting as it was possible to double check the accuracy of these against the figures given in the Census of 1961. In most cases the figures conformed very closely, though it could be that this simply means that the same errors are passed on by informants irrespective of the data collector!

The questionnaire closed with a group of more general questions which were added after the trial run of the questionnaire. It was clear that the respondents were often interested in more general questions and that such questions would also provide valuable information. The availability of work opportunities outside the village, accessibility to the nearest hospital or primary health centre, and some aspects of the tenancy system were all discussed informally. The latter point generally arose in the context of the new land ceilings legislation which the Government of Tamil Nadu had just introduced, through which the maximum size of holding was being reduced from 30 to 15 standard acres.

It is evident that the questionnaire is very limited in scope and that the accuracy of some of the responses is imprecisely known.The complications introduced to statistical calculations by this latter problem are exacerbated by the fact that many of the variables do not have normal distributions. For this reason parametric statistical tests are inappropriate unless the data are normalised. These problems are discussed further below.

The absence of a wider range of questions relating for example to labour inputs and crop

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1. The standard acre is measured according to the quality of the land. The best land is rated at one acre equal to one standard acre while four acres of the poorest land was equated with one standard acre. The maximum legal holding was thus reduced from 120 acres to 60 acres of dry land or from 30 to 15 acres of wet land.

yields is regrettable , even if unavoidable. Several writers have shown how difficult it is to collect reliable data on labour input in Indian villages (Allan 1974), even when extensive assistance is available and a lengthy time period covered. Baker (1975) has also demonstrated the difficulties of measuring crop yields, supporting the experience of the National Sample Survey whose own crop cutting experiments have been widely regarded as falling short of entirely satisfactory. Clearly no such work could even have been attempted in thepresent study even had it been directly relevant to the analysis. As it is a considerable body of original data relevant to spatial and regional patterns of development and change was collected, and this forms the basis of the subsequent analysis.

2.10 Secondary data sources

It has already been made clear above that additional statistical material was collected from the National Sample Survey and from the Census of India , 1961 and 1971. National Sample Survey data were collected from the 23rd Round survey. The sample was a two stage sample, in which data were collected from a sample of households from each of the sample villages. The data related particularly to household expenditure on a variety of basic goods and to the nature and extent of retail trade within villages. The Census data relate largely to demographic variables, although the District Census Handbooks also contain a considerable amount of supplementary statistical information at the village level. Some of this material has been used in the subsequent analysis. Although the reliability of some of the demographic and occupational information presented in the Census has been questioned by writers such as Thorner and Thorner (1961), the basic population data were shown by post-Census checks to be extremely accurate. The most important non-statistical sources are the gazeteers published for each district. These provide an abundance of local historical and geographical detail, which although well worked over remain an indispensable source of information.

The most intractable problem hindering geographical analysis is the non-availability of large scale maps. Unfortunately the 1:50,000 series of maps currently being produced by the Survey of India and the old 1:63,000 maps are largely unavailable as they are classified documents. The best maps available in the field were the district maps, which in terms of all the criteria of map production are poor and very inadequate. This inadequacy made the analysis and interpretation of accessibility and its relevance for development considerably more difficult and less refined than would otherwise have been the case.

2.11 Analytical techniques

In the later sections of this study specific hypotheses relating accessibility to regional patterns of development and agricultural change are advanced. These are tested by statistical procedures. All the procedures used are elementary. Where statistical analysis of the data is appropriate it is restricted in its application to the examination of the hypotheses under discussion. They are not used as a hypothesis generating device. Thus such techniques as factor analysis and principal components analysis which have been increasingly applied in geographical research are not used. This may appear to be neglecting a powerful tool of statistical analysis, particularly appropriate where a large body of data exists for a wide range of variables. It is clear that the data analysed in the later chapters of this thesis conform to these conditions, and it might be argued that in order to amke sense of this multivariate reality it is necessary to group the variables together into statistically significant factors. These factors might then be expected to account for a high proportion of the variance in the data set. This approach is not followed for two reasons.

1. In many studies where factor analysis has been used it has appeared to lead not to greater objectivity but to a highly subjective interpretation of the factors which emerge. This subjectivity is related to the problem of what may be termed the "washing machine effect", that is, that as many variables as possible are thrown together stirred vigorously and then extracted in a different and hopefully "cleaner" or more meaningful form. By its nature the technique is not suited to testing specific hypotheses, and the interpretation of the results of factor analyses is complicated by the frequent absence of a suitable and relevant theoretical framework.

2. The variable nature and quality of the data makes it necessary to adopt normalisation procedures if parametric tests are to be used. In the factor analysis approach the variable quality of the data is hidden by the procedure.

For these reasons the most appropriate statistical tests for the purposes envisaged in the current analysis are those which allow individual variables to be examined separately. This carries with it risk of overlap of information and the possibility that some relationships may appear to be statistically significant which are in fact the result of the operation of a third or fourth variable. This danger is accounted for by the procedure of using control variables when any form of correlation analysis is applied. Details of the procedures adopted are discussed subsequently in Chapter Seven.

2.11 Conclusion

The focus of this study is on a relatively narrow aspect of the development process. Data have been collected for a considerable range of variables which have a bearing on the theme of economic change and regional patterns of agricultural and consumer innovation in the villages of southern India. Many of the variables for which data have been collected have been selected not for their own interest but in view of their possible influence over the agricultural and consumer variables which are central to this analysis. For this reason the patterns of distribution of several variables are not explicitly discussed or analysed in the subsequent study. They are used only as control variables to test for genuinely significant relationships. Before this stage of the analysis can be reached however it is necessary to analyse the regional character of the resource base and its impact on the nature of the agricultural development problem in Tamil Nadu. This is undertaken in the next Chapter.

CHAPTER THREE

Tamil Nadu: Physical Systems and Regional Development

3.1 Introduction

The modern State of Tamil Nadu is the remnant of what in the British period was the Madras Presidency.As the original seat of British authority in India Madras grew to assert its power over most of the southern peninsula. The administrative area was reduced under the States Reorganisation Act, 1956, which made State boundaries conform to linguistic areas. Thus re-organisation made clear an element of social organistaion that long pre-dated the arrival of the British. For the region of Tamil Nadu (" Land of the Tamils ") was the site of some of the earliest civilisations in India and some of India's most long-lived and powerful kingdoms (Basham 1962).

Although the modern State represents only a fraction of the area which formed the Presidency, it still covers a large area. Despite the considerable natural diversity within it, there is also a degree of homogeneity. It lies in the south-easternmost part of the Indian peninsula, with the Bay of Bengal linking it to South-east Asia with which it has had extensive contacts in the past. Indeed it is impossible not to be struck by the economic and social importance which still attaches to this contact for some of the villages along the east coast of Tamil Nadu. In the west the State is separated from Kerala by the hills of the Western Ghats which for most of their length form a natural boundary, pierced significantly only in the Palghat Gap. These hills extend to the north-western part of

Tamil Nadu where it meets the State of Karnataka, formerly Mysore. Only in the north where it has a common border with Andhra Pradesh is there no obvious natural divide, though even here the border runs through a region of sparse population and arid hills (Figure 3.1 and Figure 3.2).

It would be misleading to suggest that because of its natural configuration Tamil Nadu forms a neat and self-contained unit. The developed transport network shows how far that is from the truth, for Madras city forms the centre of a functional region that extends to all three neighbouring States. Despite its eccentricity to the rest of the State Madras has become a nodal point for both the State and the region (Figure 3.3) , and Berry's (1967) analysis of commodity flows in India shows clearly the extensive contacts of Madras in the modern Indian economy. However, uniformity of language and cultural tradition, exemplified in the art and architecture of the region, give both historical justification and a current raison d'etre to its Statehood.

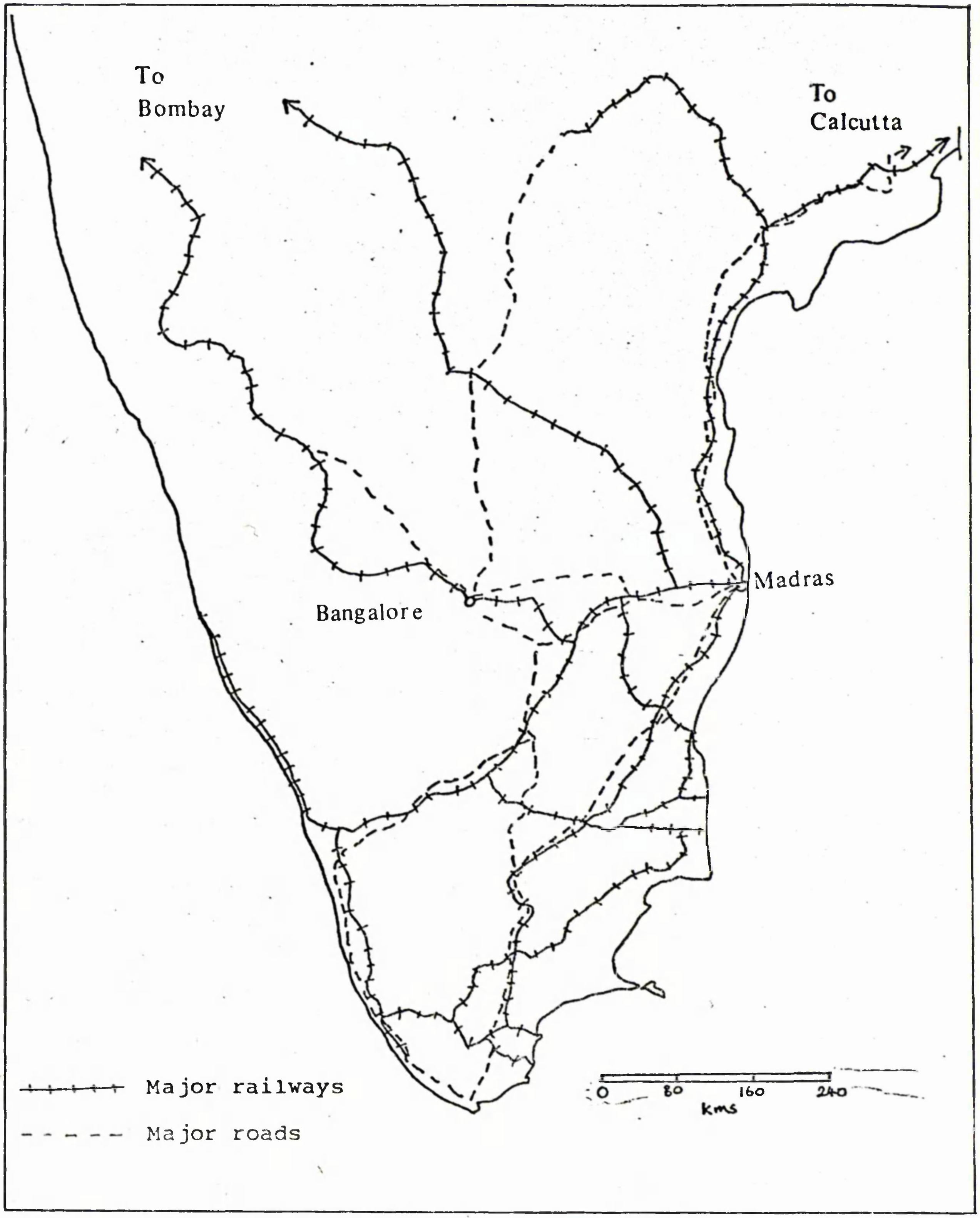
Within Tamil Nadu there are considerable contrasts in the physical and social environment, many of which have an important bearing on the patterns of agricultural activity found in the State. In this Chapter the regional characteristics of the physical systems are examined with special reference to their influence on development. Subsequent Chapters examine the regional contrasts in the demographic and socio-economic structures.

Chorley (1971) has pointed to the value of the systems approach in many fields of geographical research. Such an approach has

Figure 3.1 The northern borders of Tamil Nadu: Tiruttani Taluk

Figure 3.2 The north-western borders of Tamil Nadu: Salem District

Figure 3.3 The nodality of Madras



considerable potential value in the context of this study, for it enables the complex web of interacting variables which all play some part in the process of development to be sorted and their interaction assessed. For this reason the next three chapters are couched in systems terms, even though the analysis does not make use of advanced systems concepts.

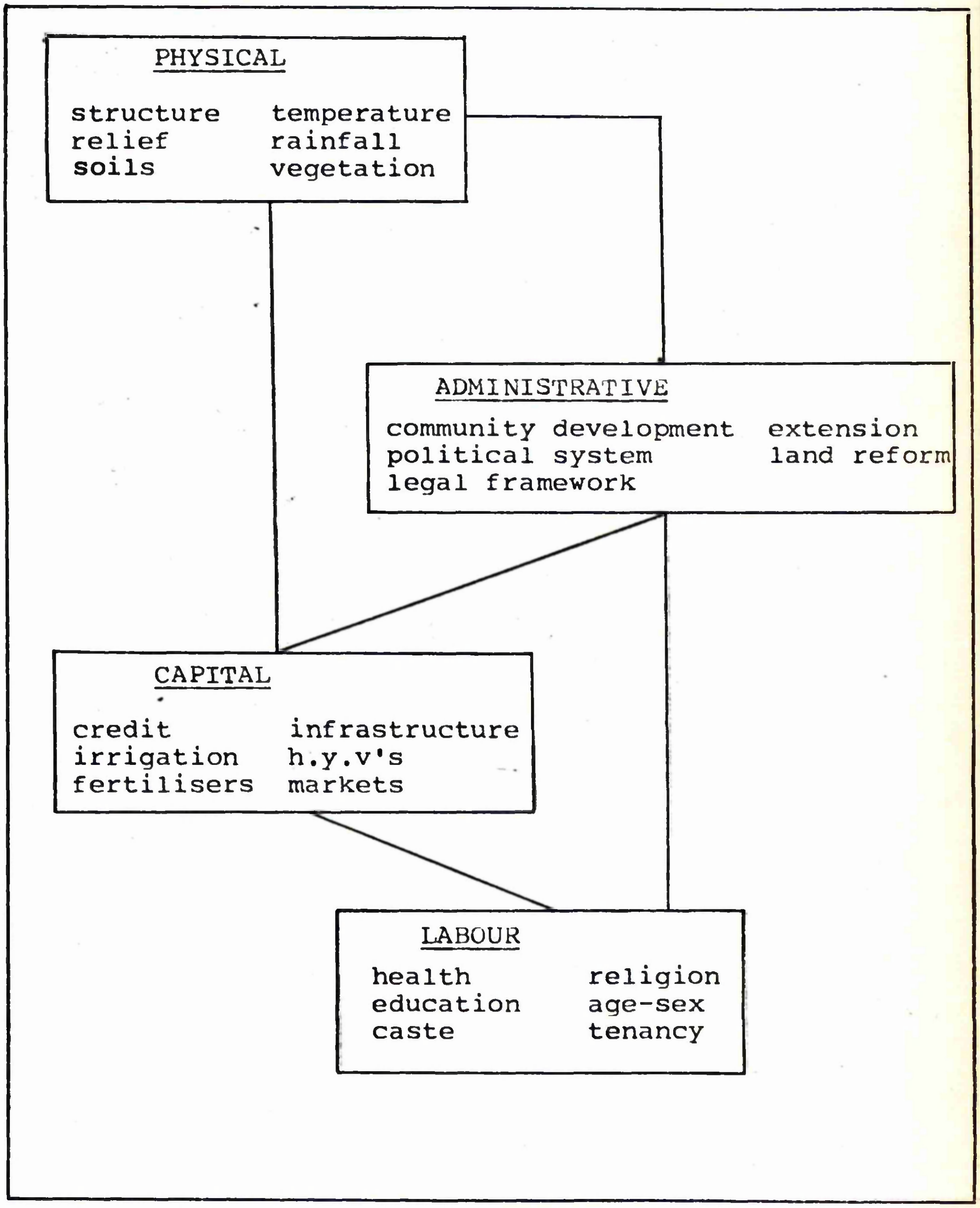
The complete agricultural system can be seen as being related to four sub-systems. These relationships are illustrated in Figure 3.4. The four sub-systems are :

1. The physical sub-system, comprising the basic variables of structure, relief, soils and climate.
2. The capital sub-system. Within this sub-system are such components as credit availability, fertiliser and high yielding variety use and the development of a rural infrastructure.
3. The labour sub-system, in which may be included the range of relevant demographic variables.
4. The administrative subsystem. The structure both of the administrative and the labour sub-systems has an important influence on the ability and willingness of peasant communities to adopt new agricultural practices.

The value of the systems approach lies not just in the manner in which it lays out the different components of the complete system thereby facilitating their comprehension, but in the highlighting of those elements of the system which are interrelated and which therefore have a bearing on the behaviour of other parts of the system (Bernard 1976). The nature of the most important of these relationships is indicated in Figure 3.4 which illustrates the structure of the interrelationships between the variables in the four sub-systems. These

Figure 3.4

A schematic diagram of the agricultural system



This may be seen as a greatly simplified model in which at the lowest level the various elements could be represented as a morphological system. As such the components would be linked in a correlation network, showing positive and negative relationships between the variables. Such a model is shown in Figure 4.1, Chapter Four.

relationships are expressed visually by lines connecting related variables, but the relationships could in theory be measured in terms both of their direction and their strength. Such measurement raises considerable problems in practice, and it is only the purpose here to use this as a descriptive tool by means of which significant aspects of the regional structure can be presented and analysed. In the remainder of this chapter attention is focussed on the physical sub-system.

3.2 The physical sub-system

Geographical research has shown an increasing tendency to adopt the simplifying convention of the isotropic surface, and thereby to ignore those disturbing features of the environment which have a disturbing tendency to overturn the best thought-out concepts and models. Lösch's dictum (1954) " if reality does not conform to the model then reality is wrong " has been the watchword of increasing numbers of geographers. Despite the contributions of location theory to our understanding of spatial patterns of organisation both of industry and of agriculture, it is impossible to analyse the factors which contribute to regional variations in agricultural change without reference to the physical environment in which such changes take place. For the individual farmer the most important elements of this environment are soils and climate, but in the wider perspective structure and relief also play a part.

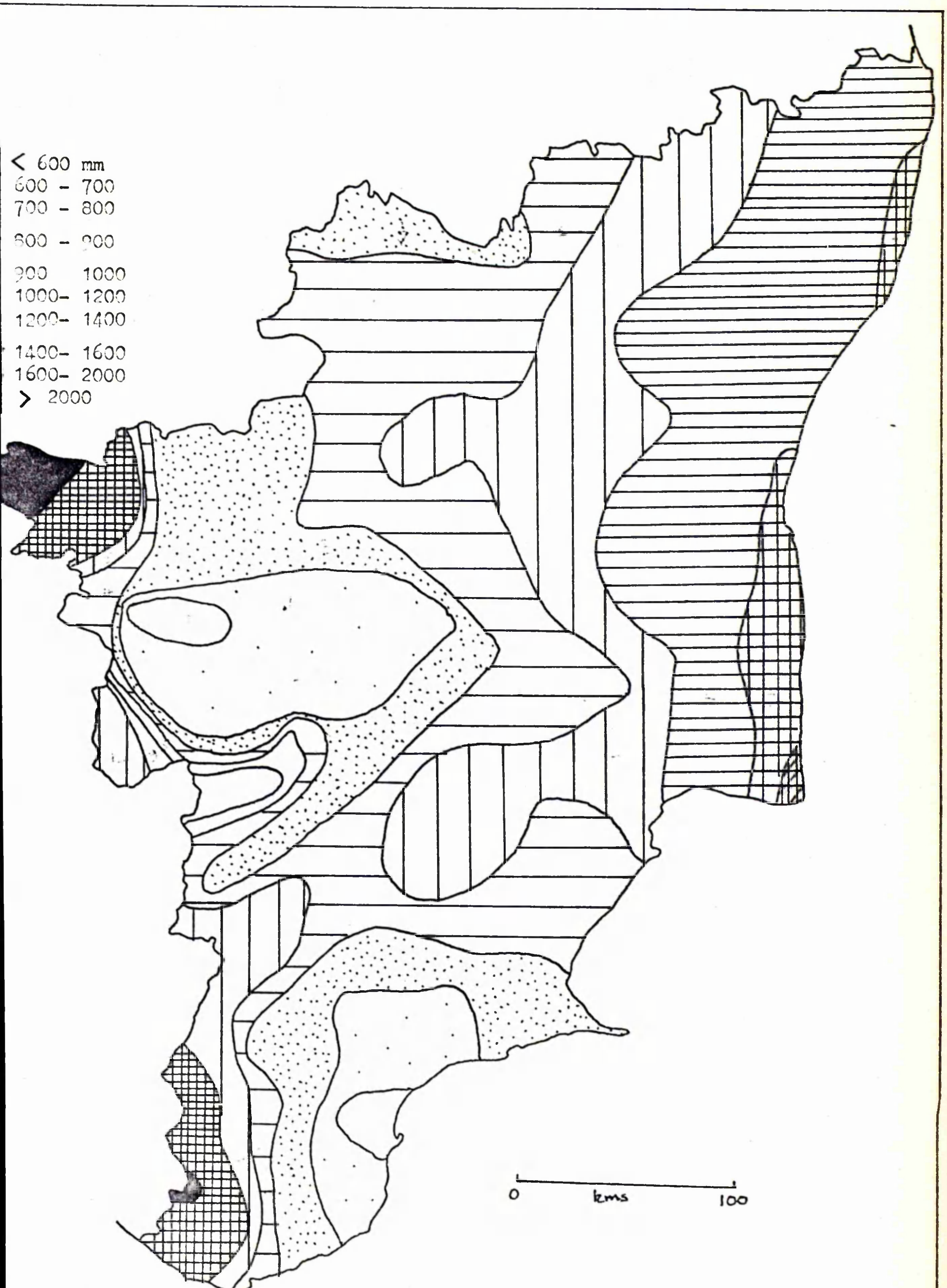
3.2.a. Rainfall : The fourteen districts[1] of Tamil Nadu contain striking contrasts in all

1. Since 1971 these have been increased to sixteen districts.

of the major environmental components. Figure 3.5 shows the regional distribution of rainfall in the State. Like other regions of eastern India to the east of the Western Ghats, Tamil Nadu has a relatively low mean annual rainfall (generally less than 1000 mm per annum) and high year round temperatures. Although the summer temperatures are never as high as those of the northern plains, evapotranspiration rates are high. Unlike the rest of India the major part of the rain falls in the period October to December, when cyclonic depressions associated with the waning south-westerly monsoon come in from the east and south-east (Flöhn 1971). The lack of rain during the earlier part of the monsoon period is the result of the State's location in the lee of the Western Ghats, which effectively prevents the penetration of anything other than a few showers between May and September.

The general picture of rainfall distribution is modified considerably when the regional pattern is examined. These regional variations, shown in Figure 3.5, reflect the fact that most of the rain is brought by westerly moving storms and depressions. Thus the general pattern is one of decreasing rainfall from the east coast and from the northern part of the State. Exceptions to this general pattern are found in the Nilgiri Hills and the more isolated small groups of hills labelled by Spate (1968) as the " Tamilnad Hills". These hill groups, reaching heights of over 2000 metres , are sufficiently high in the west to benefit from the main thrust of the monsoon itself as well as to receive additional rain from local thunderstorms.

Figure 3.5 Rainfall in Tamil Nadu



(Source: Census of India 1961)

Despite these local variations the overall pattern of rainfall distribution is well marked. In the north of the State it is the westernmost districts that suffer most severely from drought. This is testified not only by the accounts of drought in the nineteenth century but by severe droughts in the present day.[1] North Arcot, Salem and Dharmapuri all suffer from a water deficit, sometimes of considerable seriousness. For Salem and Dharmapuri in particular such droughts are the more serious because most of the farm land is unirrigated. The constraints which the absence of reliable water supply imposes may be inferred the maps of population density discussed below. To the south the inadequacy of rainfall becomes significant nearer the coast, and in the absence of irrigation has striking effects. Thus in Ramanathapuram and Tirunelveli Districts, where the rainfall is less than 600 mm per annum, semi-desert vegetation and biotically induced savannah are found over extensive tracts. Of Tamil Nadu's 134 taluks the Government has listed thirty-one as being chronically affected by drought. Of these thirty-one, eighteen are in the districts of Dharmapuri, Salem, Ramanathapuram and Tirunelveli.

3.2.b Temperature: As the entire region lies between $8^{O}N$ and $14^{O}N$ temperature is not generally a constraint on agricultural activity. However, where the altitude rises to more than 500 metres the ameliorating effect on temperature makes possible quite different forms of agricultural activity. The presence of tea plantations in the Nilgiris and Anamalais, the potato cultivation around Ootacamund and the specialisation in spices

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1. In 1975 Madras city experienced severe water shortages, allowing piped water to be made available on only one day in three. Similar shortages were experienced in other parts of the State.

such as ginger and cardomom all reflect the amelioration of temperatures as well as the significantly heavier rainfall experienced in the Hills.

<u>3.2.c Aridity:</u> The seasonal character of the climate in Tamil Nadu set it apart from the rest of the sub-continent. However, as elsewhere in India it is not simply rainfall totals and temperature variations which are significant but the combination of the two. This relationship may be expressed as the degree of aridity, and some scholars have argued that it is this which is of greatest significance for patterns of agriculture. De Martonne calculated an index of aridity based on the relationship between mean rainfall and mean temperature which Adiceam (1968) has used to illustrate the pattern of water supply scarcity in Tamil Nadu. On the basis of the formula

$$I = P / T + 10$$

where I = the index

P = Precipitation in millimetres

T = Degrees Centrigrade

he calculates the aridity index for the different weather stations of Tamil Nadu. An index of 25 indicates a level at which the mean annual rainfall barely allows agriculture to be practised without some form of supplementary irrigation.

The value of a crude index such as this may be challenged on the grounds that mean annual figures either of rainfall or of temperature are a very inadequate guide to the problems of agriculture where seasonal variations and the probability of receiving certain types of weather may be far more important . Gaussen attempted to overcome some of these problems by relating rainfall in each month to the temperature in that

Figure 3.6 A semi-arid tract in Coimbatore District

month. While this again uses mean figures, it does give an indication of seasonal variations in water deficit not shown by the de Martonne index. Three different types of regime are identified by Adiceam. Regions in the north-eastern part of the State have one dry season per annum. This zone stretches from Vellore to Madras in the north, Salem to Nagapattinam in the centre and just touches the southern coast near Tuticorin. The interior plains have two dry seasons in the year. This region embraces Coimbatore, Madurai and Tiruchirappalli. Finally, the hill regions have no period of water deficit. This results not so much from the increased rainfall as from the lowered temperatures which in turn result in lower evaporation rates.

<u>3.2.d Structure and relief :</u> The major climatic trends are complicated by the diversity of structure and soils. Tamil Nadu is composed of the basal gneisses and schists which make up the major part of peninsular India. In many areas these are covered either by Tertiary sandstones of the Cuddalore group or by recent alluvium of fluvial or marine origin. The State falls into three main relief regions: the Western Ghats and their related hills , the plateaus of Mysire, Baramahal, Coimbatore and Madurai, and the plains of Coromandel, the Cauvery delta and the South. A full discussion is given by Adiceam (1968) and a brief outline by Spate and Learmonth (1968), and here only the salient features of structure and relief are discussed.

Figure 3.7 illustrates the character of the western group of hills. The Nilgiri Hills are the most important range, both in terms of their area (2,590 sq. kilometres) and in terms of their general height (between 1,800 and 2,000 metres, reaching a maximum height of 2,633 metres at Dodda Betta). These hills form an

Figure 3.7.a The Western Ghats: the east facing scarp, Madurai District

Figure 3.7.b The Western Ghats: The Nilgiris near Ootacamund

irregular triangle in the west central region of Tamil Nadu. Most of the other major hill blocks lie to the north of the Cauvery River, though the Palani, Cardomom and Annamalai Hills continue the chain of the Western Ghats down to the southern tip of India. Of the isolated groups of hills to the north of the Cauvery, named by Spate and Learmonth (1968) the Tamilnad Hills, the Javadis (1,295 metres), Shevaroys (1,623 metres) and Kollimalais (1,421 metres) are the most important. To the south lie the Varushanad and Andipatti Hills. Figure 3.8 shows the rugged character of many of these hill blocks. All of them are inselbergs, often with sides which rise dramatically from the surrounding plains but which are topped by flat or gently rolling plateau surfaces. These form quite distinct ecological environments.[1]

The Western Ghats are pierced by only one low-lying pass, the Palghat Gap. This gap, a mere twenty-five kilometres wide, has channeled movemnet from the west coast through to the east for over two thousand years, and Coimbatore has become a nodal centre handling the traffic through the Gap. None of the other groups of hills are of sufficient size to act as more than minor obstacles to local movement.

Adiceam (1968) divides the plateaus into three groups, although the divisions are somewhat arbitrary. The first group comprises those plains in the north and west which are an extension of the Mysore Plateau. In the extreme west they reach heights of 900 metres, while between the Cauvery and the Palar Rivers

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1. In many of these areas tribal groups remain almost untouched by the outside world. Shifting cultivation is still practised where sufficient forest remains after the depredations of the last one hundred and fifty years of rising population pressure. Extremely isolated until very recently they are still only now being opened up to outside influences.

Figure 3.8 a Tamil Nadu inselbergs: the Sirumalai Hills, Madurai District

Figure 3.8 b Tamil Nadu inselbergs: outcrop near Dindigul, Madurai District

the plateau is known as the Baramahal region. This includes most of the taluks of Krishnagiri, Dharmapuri, Harur and Tiruppattur (North Arcot). It is somewhat lower at between 300 and 600 metres. The second plateau region identified by Adiceam lies to the south of the Cauvery, and is named the Coimbatore Plateau. Characterised by relatively gentle slopes the plateau rises from a height of between 120 and 180 metres near the Cauvery to over 400 metres at the foot of the Western Ghats. Further south again lie the plateaus of Madurai, which represent a further continuation of the Coimbatore Plateau. The general form of the plateau is interrupted by occasional and striking outcrops, but apart from these hills Adiceam estimates that 75% of the land of the southern plateaus is cultivable.

While the mountains of the west and the plateaus determine the pattern of Tamil Nadu's drainage and control the relief, most of the surface area of the State lies in the Coromandel Plains. At the coast these stretch nearly 1000 kilometres from Pulicat Lake in the north to Cape Comorin in the south. Altogether they represent nearly 60% of the area of Tamil Nadu. The topography of the Coromandel Plains appears simple and uniform, and only rarely is the surface broken by upstanding hills or relief features of any kind, other than those provided by the tank bunds. The apparent uniformity of the landscape is deceptive however and conceals important variations between the three major regions of the plains - the northern plains, the plains of the Cauvery Delta and the southern plains.

Dupuis (1968) identifies three morphological zones in the northern plains. At the foot of the western Ghats is a miocene and post-miocene erosion surface. Between Madras and Pondicherry the gneissic rocks of the old peneplain occasionally reach the surface at the coast, but elsewhere they lie buried under Jurassic and Cretaceous rocks which increase in depth from west to east. Despite the difference in origin of the major rock types it is generally impossible to distinguish the junctions of different rock types from the relief, and the whole surface is covered by thin layers of lateritic soils. This is the first region. The second region is distinguishable as a series of plateaus formed of the detrital rocks of the Tertiary sandstones. These are known collectively as the Cuddalore group. Found in various places - from the Red Hills north of Madras , Vriddhachalam, Udaiyarpalayam, Cuddalore and Pondicherry - they are formed of an ironstone conglomerate, generally of gneissic origin and frequently friable. The outcrops are generally higher than their neighbouring regions and frequently appear as cuestas between 75 and 90 metres high. Thirdly there is the alluvial zone, low, narrow and often with a considerable depth of alluvium. At Pondicherry for example the depth of alluvium is more than 165 metres. The depths are very variable, however, and occasional outcrops of granites or charnockites are found as at St. Thomas' Mount, Madras.

The second major region of thePlains is formed by the Cauvery delta, the most densely populated region of the State and the heart of Tamil culture. Topographically it is an almost uniform plain with no outstanding features - an apparently endless flat landscape dominated by rice cultivation. Its westernmost point is at Tiruchirappalli, where the Coleroon branches off from the Cauvery to form its northern distributary. For a delta it has a comparatively steep slope to the sea, falling 75 metres in less than 120 kilometres. The surface is formed from fluvial deposits lying over ancient basal rocks, and in the extreme south-east a stretch of salt marsh is found just inland of Point Calimere.

The southern plains have similar features and rock types to those found in the northern plains. However, the middle group of sandstones gradually disappears southwards, leaving the alluvium in direct contact with the gneissic peneplain. This ancient peneplain, the height of which gradually lessens southwards, covers three-quarters of the districts of Tiruchirappalli and Madurai, 80% of Tirunelveli and virtually all of Kanyakumari. The alluvial plains are a continuation of the northern alluvium, although in the south it is made up of both marine and fluvial deposits. It represents the greatest extent of alluvium outside the Cauvery delta, the largest single expanse in this region being found in the Vaigai basin. To the south of the Tambraparani River it forms a large protuberance, probably the result of infilling of a pre-existing depression between the valley and its former mouth. To the south of the Tambraparani again lie extensive tracts of aeolian deposits, giving great expanses of arid red sandy soils. These form a desolate landscape, windswept and with only scattered clumps of grass and isolated palmyra palms for vegetation. Following the Census of India (1951) Adiceam estimates that as much as 95% of the southern plains is cultivable. Farmer (1975) has shown how unreliable and inaccurate many of the Government's figures on cultivable waste can be, and there is no doubt that this figure is a considerable over-estimate. Nonetheless it gives an indication of the uniformity of the land surface.

The three major structural regions occupy unequal proportions of the surface area of the State. Adiceam estimates that approximately 2.3 million hectares lie above 600 metres. Of this perhaps only 75,000 hectares is cultivable. In many highland areas cultivation is carried out at a much lower level of intensity than on the plains, although estate and commercial agriculture clearly differ from traditional agriculture in this respect. The plateaus and plains below 600 metres cover approximately 10.7 million hectares, of which Adiceam suggests that 9.6 million hectares are available for cultivation. Thus topography alone rules out nearly a quarter of Tamil Nadu's land for agricultural purposes.

3.2.e Soils: While climate and relief are both major influences on agriculture throughout Tamil Nadu, soils are of crucial importance, particularly at the village level. The contrasting soils found in the State represent the diversity both of parent material and of their processes of formation. Despite the work of successive soil surveys much work remains to be done before anything approaching a full understanding of South Indian soils is achieved. Nonetheless, several basic characteristics are now clear.

Generally it is possible to follow Adiceam in identifying four major soil types in Tamil Nadu that are essentially uncultivable. The first of these groups is made up of the coastal sands which line the entire coast. These are of greater width in the southern part of the region, where they penetrate as much as fifty kilometres inland. Although they have virtually

Figure 3.9 Alkaline soils, Tirunelveli District

Figure 3.10 Alluvial soils in Palar Valley near Ambur, North Arcot District

no agricultural potential they are increasingly being developed for casuarina plantations which supply much needed firewood to the villages of the coastal regions as well as to urban centres. In other respects these soils have no economic value.

The second group is made up of the alkaline and saline soils which are widely scattered through both arid and wet areas. They are common wherever defective drainage is found in conjunction with saline deposits in the soil and under the almost uniformly high evaporation rates present in Tamil Nadu are easily brought into existence by faulty irrigation schemes. In some of the sodium clays pH values may reach the extraordinarily high level of 10.0, giving rise to what Duchauffour (1956) has termed " une veritable secheresse physiologique ". Many of these soils could be reclaimed given proper treatment, but the evidence suggests that since 1917, when a Government survey reported on the problem of alkalinity and salinity, the area affected has not significantly decreased. The main areas affected are in the southern and central parts of theState. South Arcot has extensive natural saline deposits, and Tiruchirappalli and Thanjavur both have areas affected on account of inadequate drainage accompanying irrigation schemes. In the central and southern districts, notably in Ramanathapuram, significant areas suffer from the adverse effects of well irrigation which makes use of brackish aquifers. The alkaline soils of Tirunelveli, on the other hand , have come about through the shallowness of the saline water table near the coast.

The third and fourth groups of non-agricultural soils are the skeletal soils found on steep slopes, particularly in the west, and lateritic formations. The latter are found at both high and low altitudes. On the plains they represent a fossil soil, formed under forest during a period of greater rainfall.[1] Lateritic patches are found from the Red Hills to the north of Madras, on the coastal plain south of Madras down to Chidambaram and Udaiyarpalayam. They are covered in sparse vegetation and have virtually no agricultural potential, being poor in all essential plant nutrients except nitrogen. High altitude laterites are found mostly on level surfaces in the hills and higher plateaus, and commonly remain forest covered. Where this is so they are rich in organic material but poor in bases and phosphorous.

All told uncultivable soils represent between 30% and 35% of the total land surface. Thus although they are locally important and their distribution can be very significant in some regions, Tamil Nadu has an unusually high proportion of its surface area covered in soil which to a greater or lesser extent can be regarded as cultivable. These soils may be divided into three main groups : alluvial soils, red soils (better referred to as ferruginous soils), and black soils.

By far the most valuable soils are those formed on the alluvium. Most of the major rivers,

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1. There is condiderable evidence to show that much of Tamil Nadu's forest cover has been removed in the last fifty to one hundred years. Murton's work on the clearance of the forest in Salem District (1976, and in progress) is shedding light on this important process.

all of which flow eastwards from the Western Ghats, have long bands of alluvium along their banks. Towards the sea these spread out and merge with the marine sands. The most extensive stretch of alluvium is that found in the Cauvery delta. This starts as much as 200 kilometres inland in the valleys of the Noyyil and Amravati. At Musiri in Tiruchirappalli District it is 40 kilometres wide, and it reaches a width of 65 kilometres in Tiruchirappalli taluk itself. The major part of the delta lies in Thanjavur District, and in all covers an area of over 15,400 sq. kilometres.

In view of their importance it should be stressed that the alluvial deposits are not uniform in their characteristics, and although they bear no relation to the rocks over which they lie they do reflect the characteristics of their source areas. Thus although all the alluvial soils of Tamil Nadu are of Pleistocene origin, always have a water table within two or three metres of the surface and commonly have profiles containing several horizons of widely differing texture, both their physical and their chemical properties vary significantly.

In the north the valleys of Chingleput District - the Kortalayar and the Palar rivers - are lined with reddish silts and sands. In the Palar valley silts, sands and gravels are mixed in uneven proportions, but are generally poor and of variable coarseness. All are derived from the gneisses of North Arcot District, while in contrast the pure sands of the Narayanavaram are derived from the grits and gravels of quartzites. To the south of this group in the valley of the Vellar River (South Arcot) the alluvium has given rise to the development of a sticky black soil, widely developed to the south-east of Vriddhachalam. In the Cauvery delta itself, the region par excellence of supposedly fertile alluvial deposits, the alluvium is derived from archaean rocks. It is generally light in colour and texture, and despite its reputation in Tamil Nadu is considerably less rich than the soils of deltas to the north such as those associated with the Krishna and Godavari rivers which drain the basaltic traps of the regur soils region of the Deccan. The alluvium in the valleys of the southernmost rivers - the Vaigai and the Tambraparani - is rather variable. In the Vaigai valley light or light brown silt predominates, with patches both of coarser sand and of finer silt intermingled. At the mouth of the river this becomes a very fine grey coloured silt or sludge when wet.

While the alluvial soils deserve their reputation of fertility they do not have unduly high phosphorous, nitrogen or organic content, although they are rich in Potassium. As elsewhere in south and south-east Asia, the alluvial soils are essentially rice growing lands. On the readily drained higher land sugar cane, bananas and other crops predominate. All these crops depend on the plentiful availability of water. Only the finest silts have a relatively high water retentive capacity, and thus the availability of irrigation water becomes a crucial factor in their agricultural use.

Ferruginous soils[1] cover two thirds of the cultivable area of Tamil Nadu. They are found

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1. Adiceam suggests the use of the term "ferruginous" in preference to that of "red soils" on the grounds that there is less risk of confusion with "laterites". This usage is adopted in the subsequent discussion.

Figure 3.11 Ferruginous soils, South Arcot District

Figure 3.12

in all districts of the region, at virtually all heights, on slopes, in valleys and over wide expanses of the plains. The distinguishing characteristic of their formation lies in the fact that they were developed in situ from the decomposition of red granites, gneisses and micaceous rocks, now often deeply weathered (Farmer 1956). Usually acid they are poor in lime and magnesium but rich in felspars and potassium. Their reddish colour is due to oxidation giving rise to ferrous oxide formation. They are shallow, and although they can reach two and a half metres in depth are more commonly between 0.5 metres and 1.0 metres deep. Low in soluble bases and salts, they are also generally poor in organic matter. Of equal significance from an agricultural point of view is their low water retentive capacity. They are highly permeable, and with the first rains are ready for sowing. Thus they can be cultivated earlier than other soils, and for this reason are referred to locally as precocious soils. The high permeability of the red soils also carries with it important disadvantages. They dry as rapidly as they absorb moisture, and thus need frequent irrigation during dry periods if crops are to survive. Their low salt content coupled with the depth of weathering which often allows aquifers to be tapped (Farmer 1956) makes them ideally suited to well irrigation. Consequently it is in such areas as Coimbatore and North Arcot that wells have made a significant contribution to agricultural productivity for a very long period.

If the ferrugionous soils are 'thirsty' they are also 'hungry'. Given irrigation water fertilisers are essential to make up nutrient deficiencies if high yields are to be obtained. The controlling natural factor in their fertility would appear to be the ratio of silt to sand.

On the basis of this ratio it is possible to distinguish five soil regions.

1. The high plains north of the Cauvery. North Arcot and Salem, the northern and western parts of South Arcot and northern Tiruchirappalli all have silt and heavy ferruginous sands on the higher ground with fine silts and clays along the valley bottoms. The higher red soils deriving from the Cuddalore sandstones around Cuddalore and Pondicherry are generally among the most infertile of the group, though they are planted with cashew plantations and groundnut.

2. In the central and western region fine comminuted ferruginous soils are characteristic. Coimbatore, Karur (in Tiruchirappalli District) Dindigul and Palani taluks are typical, and throughout the region underlying rocks frequently outcrop.

3. A group of ferruginous soils with a marked tendency to salinity lies to the south of the Cauvery. They are a mixture of clayey sands, lateritized sands and gneissic debris.

4. In southern Tiruchirappalli and in Tirupattur taluk of Ramanathapuram district there is a group of totally sterile saline ferruginous soils.

5. In contrast to the last group ferruginous soils formed at the base of the Western Ghats in the southern districts of the State formed from deep silt give a fertile base for agriculture which provides excellent potential when irrigation water is made available.

Black soils are nowhere near as extensive as the ferruginous red soils, but they make a distinctive contribution to the soil map and

Figure 3.13 Black soils near Sattur, Ramanathapuram District

Figure 3.14 Brown earths : Javadi Hills North Arcot District

to agricultural productivity. In Tamil Nadu and elsewhere where they occur in India these are commonly referred to as " cotton soils ". Their origin is still obscure, and although it is believed that they are formed in situ they are found on a variety of parent materials. There are two main regions in Tamil Nadu where black soils are found. There is a very large expanse to the south of the Cauvery in southern Madurai district and around Sattur in Ramanathapuram district. The second major region lies in the west, to the north and south of Coimbatore.

While some black soils are found on an acid parent material, they are generally calcareous with a pH value between 8.5 and 9.0. They are clays with a high degree of water retentiveness and low permeability. As with all clays they are gluey and tenacious when wet, but although they form deep fissures when dry they are also friable and granular, making it possible to work them. Among the richest of Tamil Nadu's soils, with naturally high mineral content (high potassium, calcium and magnesium, but low nitrogen), they differ from the ferruginous soils in one other important respect. Before planting it is essential that these soils are fully soaked. Consequently they require a longer period after the onset of rain before sowing can take place. However, because of the retentive character of the soil they virtually guarantee a harvest once the crop has started growing if the soil has been appropriately saturated, as they retain sufficient moisture to last through the growing season.

While the general pattern of soil types discussed above is an important factor in the regional pattern of agricultural activity, it is the nature and quality of soil at the micro-scale that is significant when village development patterns are the subject of analysis. There is still far too little known about soil properties at a village level. In very few of the villages visited in 1971 were the Block Development Officers or agricultural extension officers able to give any information about the physical or chemical properties of the soil in the villages. Although the agricultural colleges are now engaged on wide ranging research into soil properties, and detailed soil analysis is increasingly available to individual villagers there is still widespread ignorance of the chemical properties of the soil. This is not to say of course that most farmers do not have a very shrewd appreciation of the characteristics of their own land. Local terms applied to various soil conditions testify to the sensitivity of the farmers to local soil conditions. It would be strange indeed if he were unaware of this importance. However, in a situation where he is being asked to adopt new technologies and particularly where he is being pressed to use chemical fertilisers knowledge of the requirements of different soil types and of the problems each presents is a prerequisite to the rational use of resources. Widespread evidence of lodging in 1971 bore witness to the mis-application of chemical fertilisers. Both in terms of soil research and of its application in the villages a great deal evidently remains to be done.

3.3 Conclusion

Climate, relief, structure and soils are more than simply of academic interest in the context of regional patterns of agricultural development in

Tamil Nadu. In 1971 a high proportion of the village population in the State was dependent on forms of sedentary subsistence agriculture. All four elements of the physical sub-system played an important part in the nature and effectiveness of agriculture. Far from being simply an " environmental backcloth " , the constraints of the physical environment have been met in the past by detailed adjustments on the part of villagers to those constraints in the light of prevailing knowledge. That such adjustments should be abandoned should be abandoned with the arrival of new technology seems both unlikely and potentially damaging; that a new form of adjustment should be sought is more credible and almost certainly more constructive. Thus any interpretation of regional development in the State must take these factors into account. The physical constraints themselves however operate within a framework that is also shaped by the nature of the other sub-systems within the whole agricultural system. In the next Chapter the structure of the most important of these, the capital sub-system, is analysed.

CHAPTER FOUR

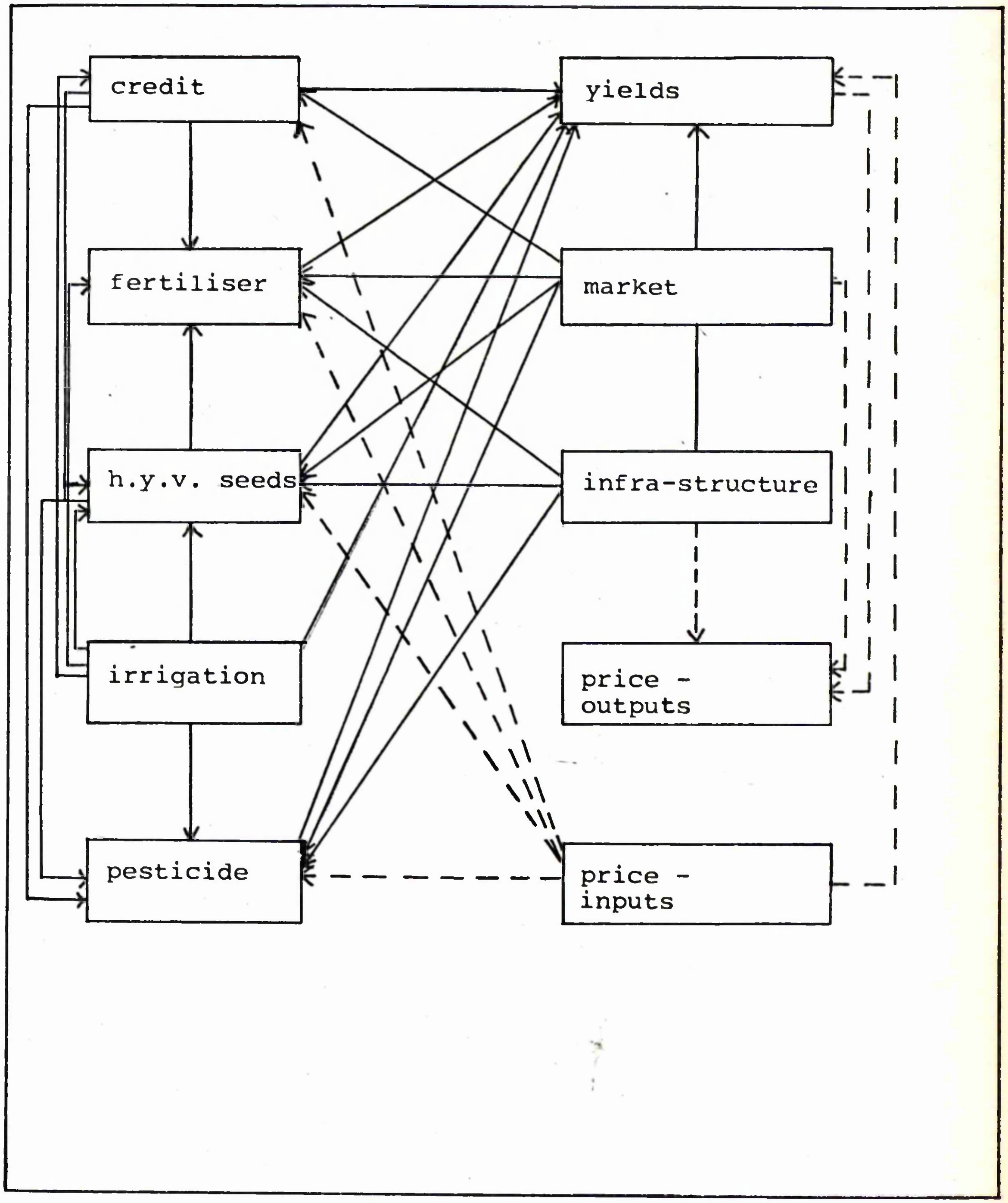
Agriculture and the Capital Sub-System

4.1 Introduction

The links between the elements of the capital sub-system (Figure 4.1) are particularly close. This suggests a high degree of inter-dependency within the system. Finance and credit arrangements, banking and co-operative activity, the availability of irrigation water and of chemical fertilisers, and the development of a modern infrastructure are all strongly correlated. Some elements of this complex sub-system have considerably less relevance to regional patterns of agricultural change than do others, and thus although they may have importance in the wider development context they receive no more than passing mention here.

In the context of a non-physical system such as is described here it is impossible to think of direct and measurable energy flows in the sub-system. Only by analogy could such energy measures be given to 'inputs' such as interest rates or the marketing system. Such analogies would be more confusing and misleading than they would be helpful, and no attempt is made to develop measurements of flows within the sub-system. The capital sub-system is more in the nature of a morphological system (Chorley 1971), in which the relationships between variables are shown in their degree of correlation rather than in the flows between them. Even so, the sub-system may be conceived of as having both inputs and outputs. The inputs may be listed as irrigation, fertilisers, high yielding varieties of seed; the major outputs as crop yields.

Figure 4.1 The Capital Sub-system



Positive links

Negative links

This Chapter proceeds to analyse the way in which these elements of the capital sub-system have interacted to affect regional patterns of agricultural change in Tamil Nadu at the macro-level, and as such lays the foundation for the subsequent analysis of village level patterns of agricultural change.

4.2 Inputs

4.2.a Irrigation: Irrigation has been practised in Tamil Nad for over a thousand years. Rivers such as the Cauvery have been controlled with increasing degrees of sophistication, dams and tanks have been constructed and wells dug. In the last twenty years rural electrification has brought a new dimension to irrigation works in several of Tamil Nadu's major agricultural regions.

Nominally Tamil Nadu has a higher percentage of its agricultural land under some form of irrigation than any other State in India. In 197-71 3.28 million hectares of cultivated land were irrigated, or 40.7%.[1] However, these crude figures are very misleading. The largest single source of irrigation water is the ubiquitous tank, which accounts for 36.6% of the irrigated area. In many parts of the State such tanks are extremely unreliable, particularly those which are entirely dependent on rainfall. Figure 4.2 shows one part of the topographical map for Ramanathapuram District , described by Spate and Learmonth (1968) as " typical tank country ". For several years together, however,

1. All statistics in this Chapter are taken from Tamil Nadu 1971; an Economic Appraisal, and from The Fourth Plan for Tamil Nadu, except where otherwise stated.

Figure 4.2 Ramanathapuram District

tanks in this district may be completely dry.[1]

In 1971 34.6% of the irrigated area received its water from canals and the remaining 27.2% came from wells. At the start of the Planning era in the early 1950's it was evident that an increase in the area irrigated was an essential pre-requisite of increased productivity in agriculture. By the end of the First Plan 2 million hectares were under some form of irrigation. The chief increases during the period had come from the implementation of two schemes, the Lower Bhavani Project in Coimbatore and the Tambraparani Scheme in Tirunelveli. By the end of the Second Plan the area irrigated had risen to 2.3 million hectares. This increase came through the Amaravati Scheme (again in Coimbatore) and from improvements to the Cauvery-Coleroon system. By 1966, the end of the Third Plan period, the area irrigated had expanded again to 2.5 million hectares. Between 1966 and 1971 however there was no expansion of the net irrigated area, and although the gross area irrigated stood at 3.28 million hectares this did not represent any increase over the previous five years.

The expansion of the irrigated area that took place during the first twenty years of Independence was not evenly spread out through the State. As was observed by the Project Evaluation Organisation of the Planning Commission (1967) projects with low costs and high returns have been favoured - not entirely unexpectedly. The general aspects of this policy have been

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1. Farmers in several of the villages surveyed in 1971 for this study reported that it was seven years since their tanks in Ramanathapuram had had any water in them. Although these were extreme examples they illustrate the problems associated with tank irrigation.

discussed in Chapter Two. In the specific context of irrigation development it has meant that technical considerations such as the suitability of the terrain and the availability of water at relatively low cost have been determining factors in choosing the locations for new irrigation schemes.

The expansion of irrigation in the modern era began under the British with the construction of the Mettur Dam in the 1930's. This expansion was given a boost by the First Five Year Plan. By this time there were already significant regional contrasts in the realised irrigation potential of the districts. There were also important contrasts between the districts in terms of the sources of their irrigation supplies. At one extreme lay Thanjavur, which received 90% of its irrigation water from the Cauvery system. This system guaranteed a supply for at least ten months of the year. At the other extreme came Ramanathapuram, which was almost exclusively dependent on tank irrigation for its supplementary water. In between few of the other districts received more than 25% of their irrigation water from canals. Tiruchirappalli (41.6%), Coimbatore (40.4%) and South Arcot (28.8%) were in this privileged group. Table 4.1 shows the relative contributions of the three major sources of irrigation for all the districts of Tamil Nadu. From this table it can be seen that the contribution made by tanks also varies very considerably from one district to another. The usefulness of tanks as an irrigation source is itself far more variable than the usefulness of wells or canals. Thus although Chingleput, North Arcot and South Arcot all had a comparatively high percentage of their irrigation from tanks in 1971, the much higher rainfall totals and the greater reliability of rainfall in these districts, pointed out in Chapter Three, makes

Table 4.1 District-wise irrigation by source 1970

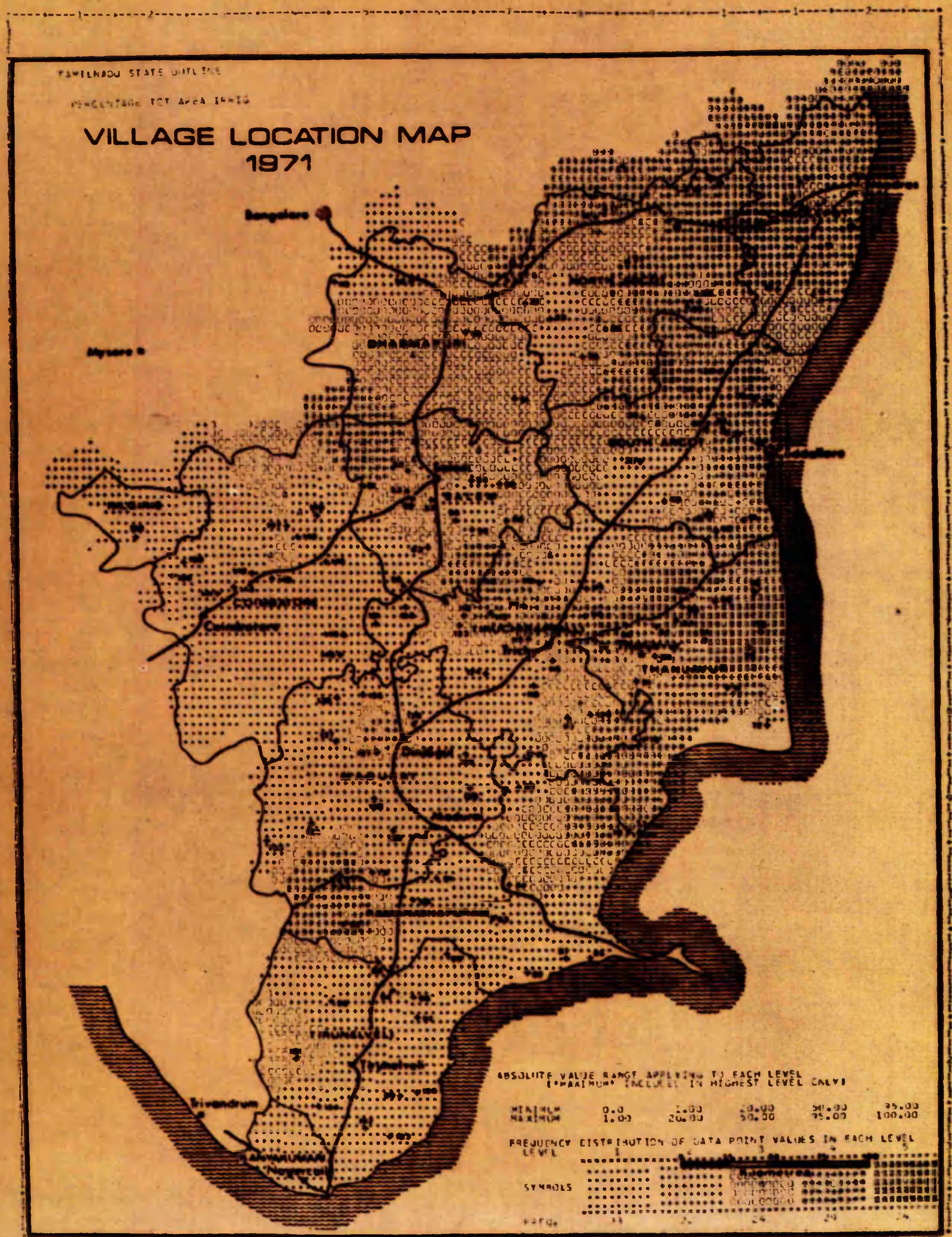
District	Well		Tank		Canal		Total a	Total b
Chingleput	61,477	25	174,512	72	5,871	3	77	29
North Arcot	130,985	50	115,490	45	12,351	5	51	21
South Arcot	120,132	40	110,174	36	73,346	24	53	29
Dharmapuri	35,145	56	17,214	27	10,457	17	15	7
Salem	90,372	74	12,801	11	18,450	15	30	14
Coimbatore	121,376	48	5,033	2	124,180	50	35	16
Madurai	85,855	43	49,004	25	64,298	32	35	16
Tiruchirappalli	78,668	33	76,474	32	82,079	35	33	17
Thanjavur	15,905	3	29,443	6	470,475	91	84	53
Ramanathapuram	40,884	17	197,251	83	585	-	38	19
Tirunelveli	58,480	37	80,313	50	20,526	13	35	14
Kanyakumari	177	1	11,505	37	19,069	62	38	18

In each column the left hand figure represents the area irrigated (hectares) and the right the percentage that that figure represents of the total irrigated area. In the total column, a is the proportion of the net sown area irrigated, b is the proportion of the total area irrigated. Source: Towards a greener revolution , Govt. Tamil Nadu State Planning Commission Report of the Task Force on Agriculture 1972.

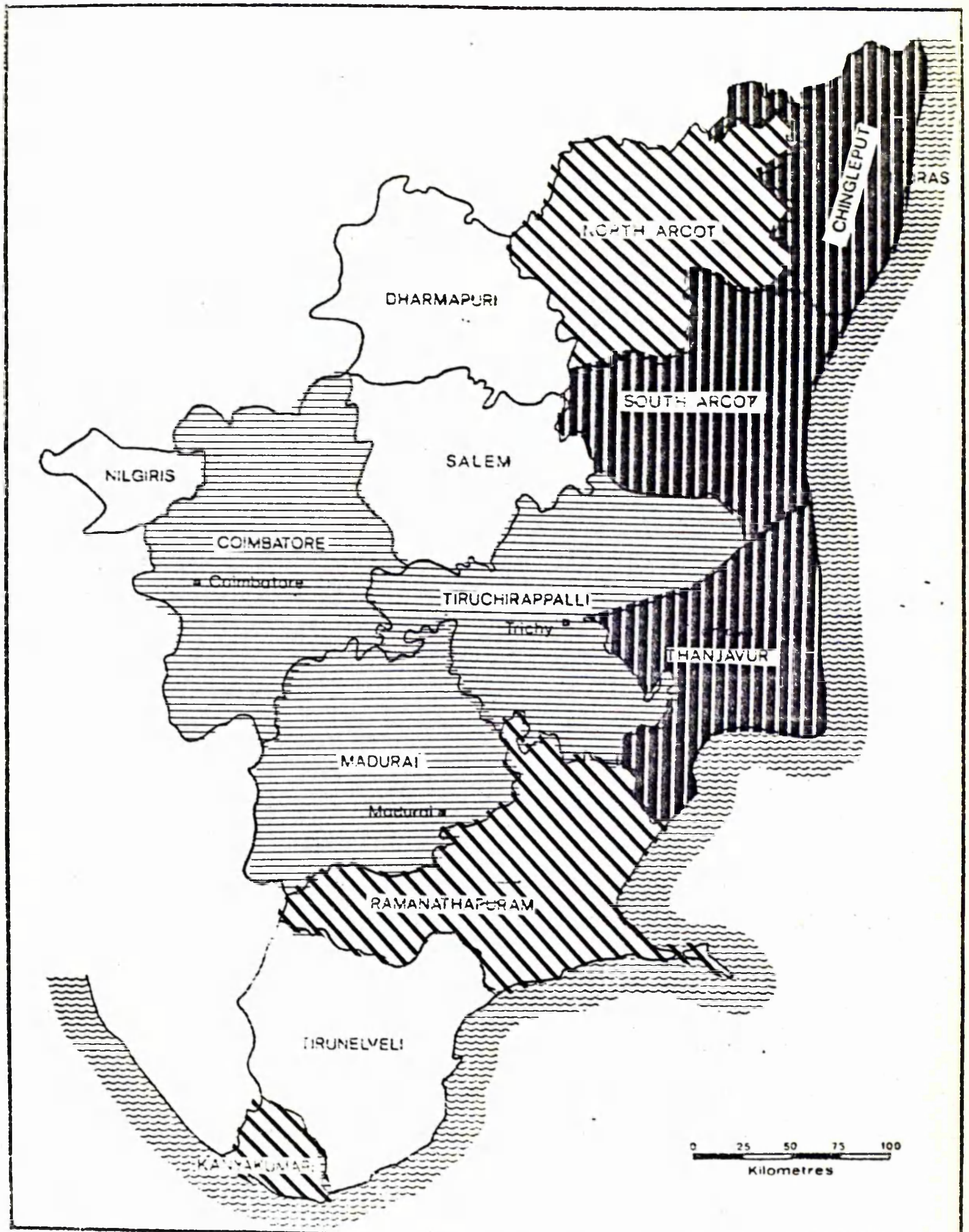
makes them of far greater utility than are those in the south.

By 1971 it was in well irrigation that the most dramaitc developments had taken place. Some aspects of the recent expansion of well irrigation have been discussed by Harriss and Harriss (1974). From the Government's published figures it was evident that the major change had occurred not so much through the sinking of new wells as through the provision of electric power, enabling electrically powered pumpsets to be installed. In 1951 there were only 14,000 pumpsets with any form of power. Most of these were powered by electricity. By 1961 this number had risen to 130,600 and by 1971 to 530,000.

Figure 4.3 Percent of total area irrigated



area irrigated

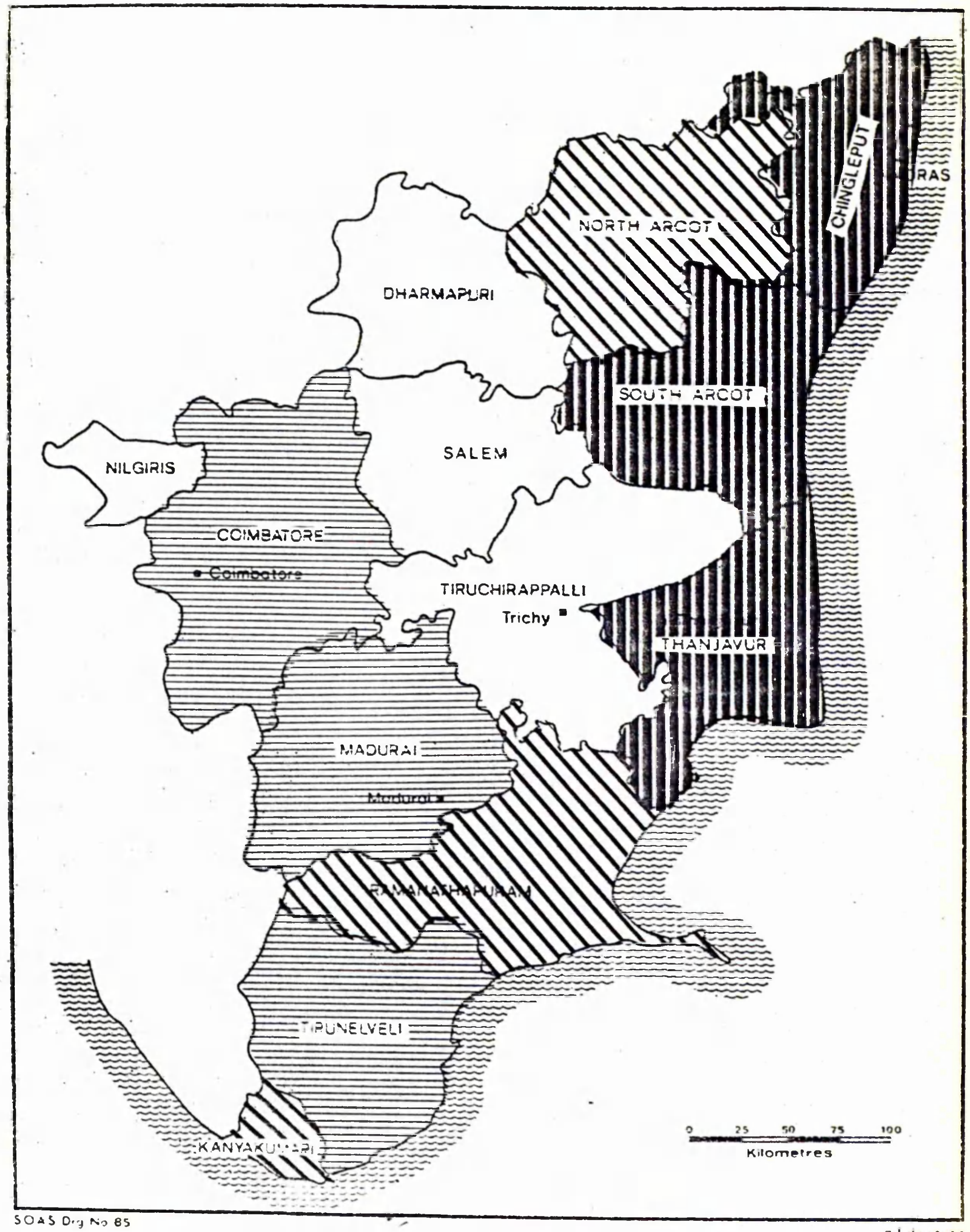


Over 28% 16% - 17%

18% - 28% Less than 16%

The classification is based on the quartile distribution.

area irrigated



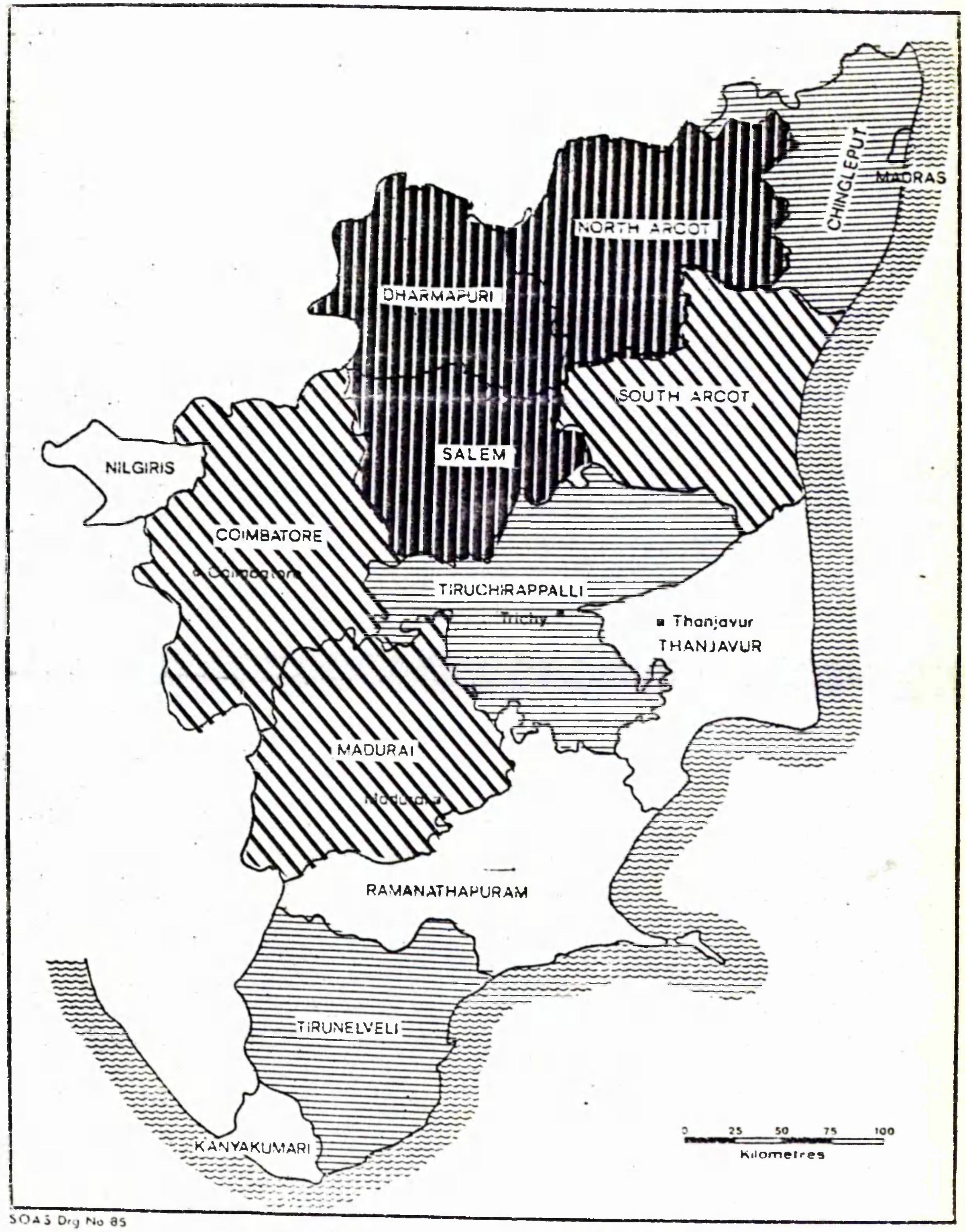
Over 53%

35% 37%

38% - 52%

Less than 34%

land



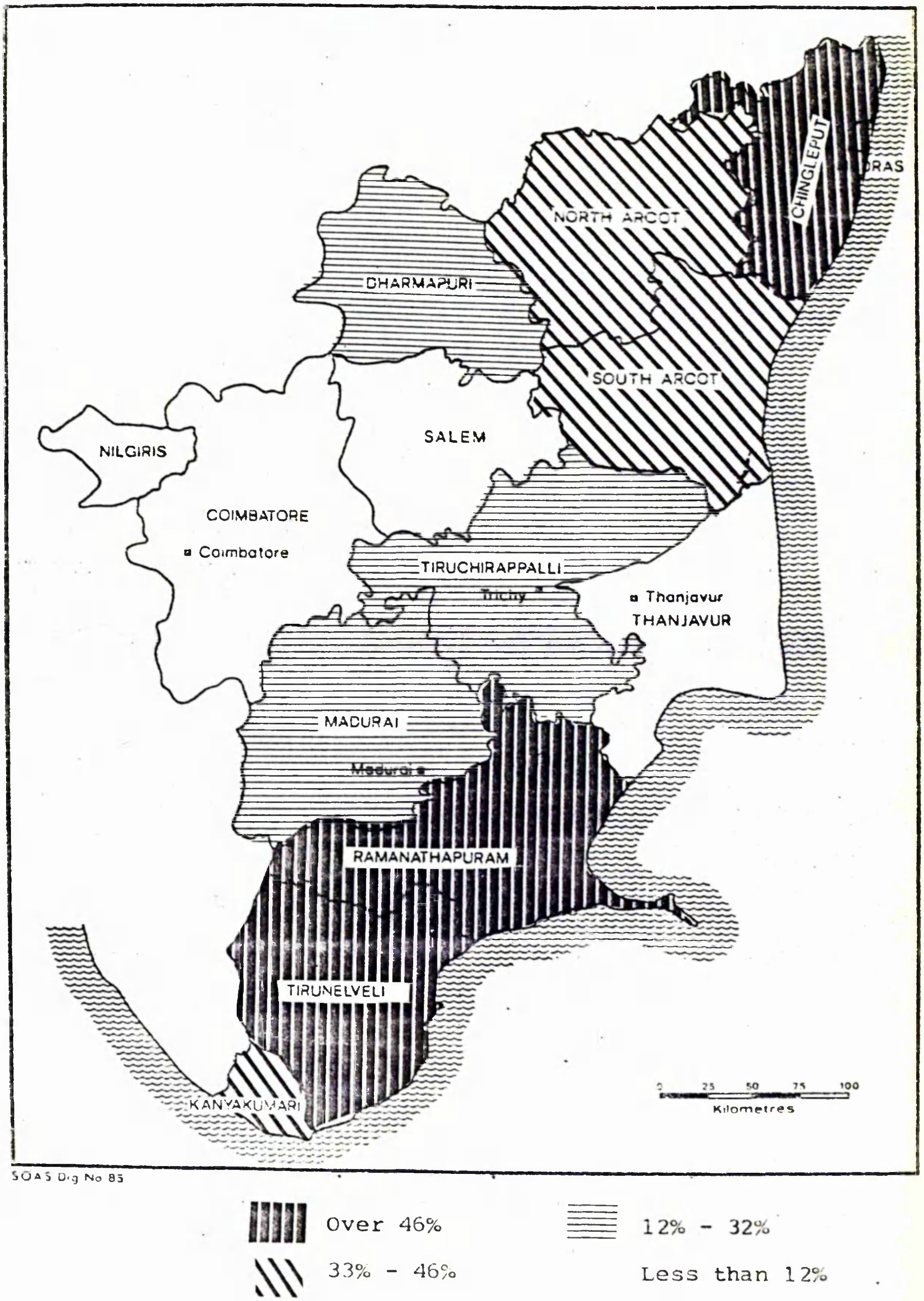
Over 49%

38% - 49%

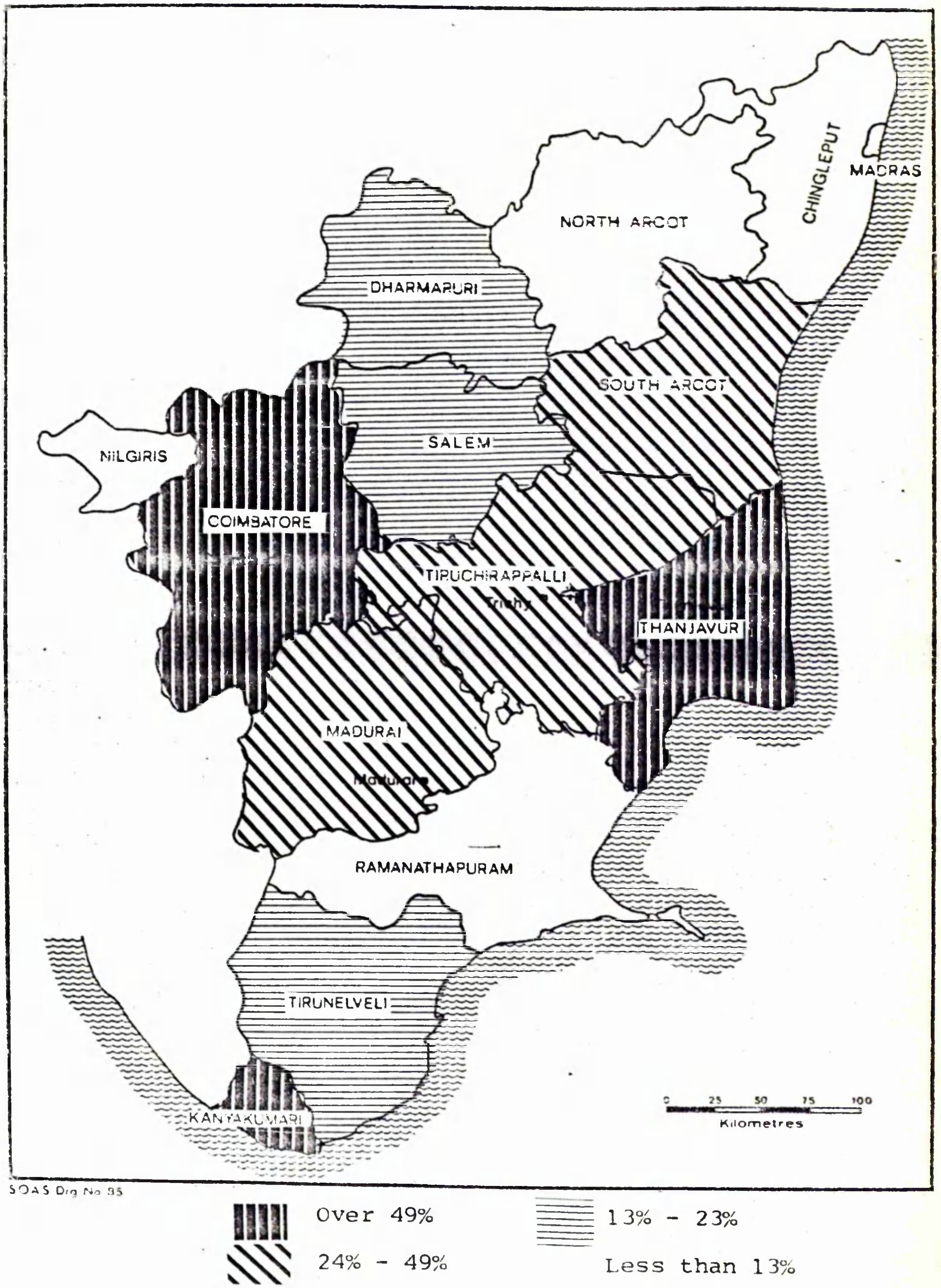
18% - 37%

Less than 18%

under tank irrigation



canal irrigation

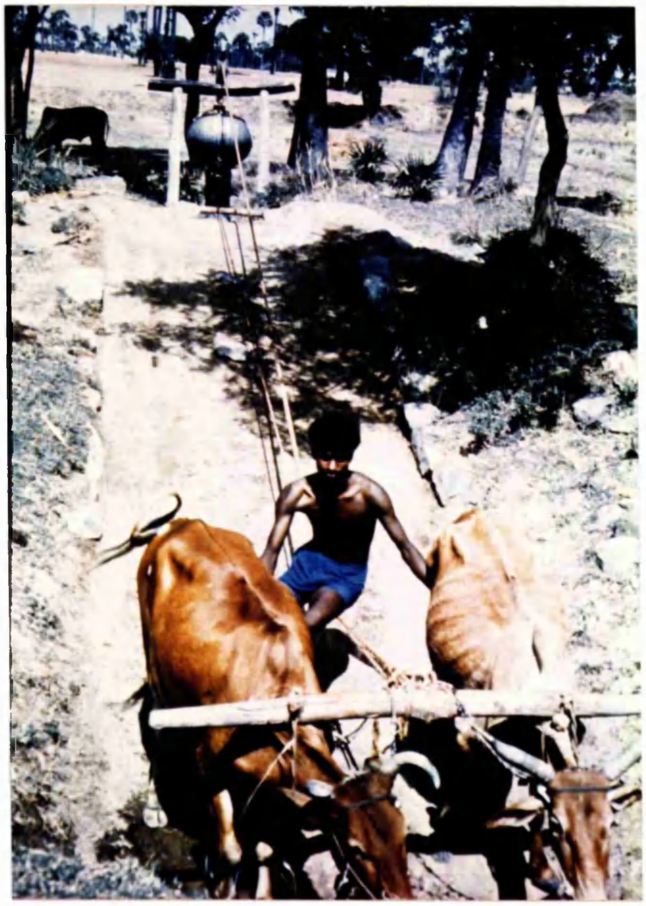


Electric pumping accounted for 19% of the total electricity sales in Tamil Nadu in 1971, compared with only 6.5% in 1951. Although the percentage figure remained constant between 1961 and 1971 the total volume of sales for electric pumping rose three times during that period. At a State level it is clear that the impact of these developments has been of great significance. However, again it must be recognised that the regional implications are far-reaching. Official statistics relating to well irrigation are only available at the district level, which is rather a coarse unit if the main focus of interest is village level change. However, it is clear that the intensification of well irrigation has taken place in two types of area.

1. Areas which were already dependent on well irrigation to a substantial extent, usually for the raising of one crop on soils where the rainfall required supplementing. Occasionally the wells were used for producing a second crop, and although parts of North Arcot, Salem and Coimbatore come into this category the practice was not widespread.
2. Areas where well irrigation supplements canal irrigation, either for irrigating a second or third crop or for advancing the season by irrigating seed beds. Thanjavur and South Arcot come into this second category.

The availability of reliable and adequate water is a critical factor in agricultural productivity and hence also in agricultural change. This view has been strongly supported by several workers in the Indian field, from the early engineers of the British canal irrigation schemes in the Panjab down to such recent writers on recent writers on problems of agricultural development in both south and

Figure 4.5 Kavalai Irrigation, North Arcot District



north India (Mellor 1972, Blaikie 1971, Harriss 1974, Allan 1975 and Baker 1975). This dependence on a reliable water supply has led to the fundamental distinction between irrigated and unirrigated land, recognised by the British system of land revenue assessment , and continued in the classification of land as " wet " or " dry ".

During the twenty-five years following Independence the contrast between wet and dry land not only persisted but intensified. The total area under irrigation increased, but this increase was restricted to relatively few localities. Superficially it appears from the aggregated statistics that every district now has a considerable proportion of its land benefitting from irrigation. Apart from the Nilgiris, which, by virtue of their high rainfall are a special case, only Dharmapuri has less than 20% of its cultivated land under some form of irrigation, and most districts have between 25% and 40%. The illusory nature of these apparently ample water supplies is shown by the figure of 42% for Ramanathapuram. To the peasant farmer of eastern Ramnad as simply another mirage conjured up in the sands.

The inefficiency of tank irrigation and the lack of available surface water over much of the State[1] has led to increasing attention being paid to groundwater development. This attention is evident from the changing pattern of investment pattern in small-scale irrigation projects, many of which are concerned with groundwater development. During the First Five Year Plan the outlay on minor irrigation works was Rs 8.42 lakh. In the Second Plan this rose to Rs 168 lakh, and in the Third Plan it rose

1. The Government of Tamil Nadu (1972) argued that surface water had now been utilised " to the fullest extent " and that there was no possibility of further significant increase in surface water irrigation.

Figure 4.6 Tank irrigation, Chingleput District

again to a huge sum of Rs 2,257 lakh. Even allowing for inflation this represented a massive shift towards small-scale irrigation projects. This shift was continued in the three one year Plans that followed the disastrous failure of the Third Plan, and outlay on small-scale projects was in the order of Rs3,000 lakh. The importance attached to the development of groundwater resources alone can be seen from the fact that during the Fourth Plan (1969 - 1974) it was intended to sink 70,000 simple wells, 10,000 private tube wells and to deepen and improve others. In the words of the Report (1972), the intention was to " tap the groundwater potential in areas not assured of irrigation ".

Although considerable research remains to be done of a purely exploratory nature the evidence to date suggests that groundwater potential is far from unlimited. The evidence also suggests that it is not uniformly spread throughout the State as the Government's report optimistically implies. No indication was given in the Gov rnment's plan as to how the 70,000 simple wells were to be located. Greater attention should perhaps be focussed therefore on the specific proposals that had been brought forward by 1971. These allowed for the sinking of 6,000 new wells in Thanjavur, 2,000 each in Coimbatore and Salem, 800 in North Arcot and Ramanathapuram and a further hoped for 1500 private wells in Ramanathapuram. Such figures need further examination if their impact on regional patterns of irrigation is to assessed. Adiceam (1968) points out that in the 1960's the number of wells in use in Ramanathapuram was actually declining due to the increased brackishness of the water from many of the wells. In 1960 and 1961 alone 5,000 wells were

Figure 4.7 Large-scale irrigation development: Sattanur Dam, North Arcot District

Figure 4.7.b Tube well irrigation, Madurai District

reported as going out of use. Furthermore there is growing evidence that in Coimbatore the water table is sinking rapidly. Field research carried out by Harriss in 1974 suggested that both in Coimbatore and in North Arcot wells were being deepened every year, and already wells in parts of Coimbatore are over 40 metres deep. The evidence points to water mining on a significant scale , with replenishment notably failing to keep pace.

For these reasons the Fourth Plan programme can be seen as an attempt to make good the losses rather than to open up new areas to irrigation. The root of the difficulty lies in the geological structure of the entire region. The basal archaean granites and gneisses only have aquifers in the deeply weathered interfluves (Farmer 1956) The granites themselves have very low water bearing capacity. J.P. Waltz (1969) has shown that the permeability of granite, which is among the least permeable of rocks, is never more than 0.01 gallons per $foot^2$ per day, even in deeply weathered material. This contrasts with some alluvial deposits which may have a permeability as high as 10,000 gallons per $foot^2$ per day. As has been shown above, only the alluvium filled valleys of the Cauvery, Amaravati, Palar, Ponnaiyar and Tambraparani hold out any prospect of significant and usable water resources apart from the weathered interfluves, the capacity of which are already being stretched beyond the limits they can bear.

The pattern of developments in irrigation up to 1971 can be seen to have favoured those areas most likely to bring rapid growth in output. Coimbatore is the only district which entered the 1950's without a widely developed irrigation system but which by 1971 had benefitted significantly from irrigation

Figure 4.8 Unirrigated cotton. A fully mature crop near Sattur, Ramanathapuram District.

Figure 4.8.b Irrigated cotton, Sattur Ramanathapuram District

developments. Most of the remaining investments were made in areas that were already relatively favoured in order to maximize the potential returns. The regional implications of the developments in irrigation play an important part in the regional patterns of development of the other elements of the capital sub-system, and these are examined below.

4.2.b Fertilisers: The data relating to chemical fertiliser consumption are among the most reliable of any relating to agriculture in India. Hence the figures which show an increase in NPK fertiliser consumption from 1.17 lakh tonnes in 1965-65 to 2.9 lakh tonnes in 1970-71 give a good indication of the growing awareness of the benefits of using chemical fertiliser. The statistics relating to the use of green manures are far less reliable, and the figure of 2.29 million hectares receiving green manure quoted by the Tamil Nadu Government is almost certainly over-optimistic.

Although chemical fertilisers made a considerable contribution towards increasing output, their use also tended to differentiate further between the wet and the dry lands. No regional breakdown of fertiliser use is published, but there is considerable evidence to suggest that virtually no unirrigated land receives applications of chemical fertiliser. Outside Chingleput and North Arcot districts this also applies to tank irrigated land. There are three main arguments which point in this direction. First, in 1971 there was not enough chemical fertiliser available to meet the needs of the irrigated lands alone. Secondly, farmers commonly argued that they would not waste scarce resources on applying fertiliser to unirrigated land. There are good technical reasons for this, of which the most important is the danger of the crop being chemically burnt in the event of a failure of the rains (Chapman 1974). However, in most cases it is more probably a reflection of the farmer's calculation of risk. On unirrigated land the application of fertiliser will certainly be a waste of capital should the rains fail even if no damage results. Thirdly, by 1971 the increasing use of high yielding varieties of seed had already raised the demand for chemical fertiliser far beyond the available supply. High yielding varieties were grown almost exclusively on irrigated land, and thus even had farmers wished to use fertiliser on dry land there simply was not enough to go round.

The apparently clear cut distinction that has been made thus far between " wet " and " dry " land is somewhat misleading if interpreted to mean that villages are either one or the other, for there is a third category of land in many Tamil Nadu villages which can play an important part in the agricultural productivity of the village, garden land. It is very difficult to obtain statistics from official sources on the extent of garden land cultivation, which almost by definition is normally in the "informal" sector. In some areas where the use of such land is restricted to very small-scale production of vegetables to supplement the diet, such lack of information is unimportant. In some villages however garden land occupies considerable areas and represents very intensive cultivation. This can significantly affect the levels of living in the village. While lack of detailed information concerning garden land precludes its being taken into consideration in the subsequent analysis, it is recognised that in some cases such land can affect the agricultural characteristics of the village.

In view of the weight of the supporting evidence it can clearly be accepted that very limited amounts of fertiliser are spread on dry land. It follows that in 1971 as much as 70% of the cultivated area of Tamil Nadu remained without the benefits of either a reliable water supply for irrigation or of the application of fertilisers. This situation is exacerbated by the fact that in many unirrigated tracts no other forms of input are available . In some areas tank soil (the fine silt deposited on the bottom of tanks) is collected and put on the land, and where available green manure is also applied Providing the only form of organic enrichment of the soil, which as was shown in Chapter Three is notably absent from most of both the alluvial and the ferruginous red soil tracts, increasing pressure on the land has made it more difficult to obtain. Thus in many regions the practice of using leaves from the forest, reported in nineteenth century gazetteers, has now largely died out as the forest margins have been pushed further and further back.

Even on the irrigated land fertiliser application is by no means uniform, as can be seen from Figure 4.9 . If all the area estimated by the Government as being under high yielding varieties were receiving the recommended levels of fertiliser the total requirements of these crops alone would have been more than three times the total annual consumption. Although as is shown below there is little doubt that the Government's estimates for high yielding varieties were considerably over-optimistic, it was also clear from my own survey that the farmer who applied the recommended dosage was the exception rather than the rule. The major reason for under-application lay in non-availability of fertilisers, but in many areas the non-availability of credit in sufficient quantities on sufficiently attractive or feasible terms were also contributing factors. This was the case despite offers at favourable rates by Block Development Offices. In a region where the great majority of farms are of less than 2 hectares, inability to generate savings still appeared to be a major problem in 1971.

The regional patterns of fertiliser use as reported in the survey carried out for the present study in 1971 are shown in Figure 4.9 . It should be stressed that the unit of data collection on which these maps are based is the village, and the sample size of 132 villages means that there is a considerable degree of generalisation. Despite this weakness the maps give an impression of regional patterns of fertiliser use not available from any other source. The great majority of the State is shown as lying in the lowest category of fertiliser use for dry land, that is between 0% and 1%. The only deviations from this pattern are found in North Arcot, South Arcot, Tiruchirappalli, Madurai and the Nilgiris. In all cases fertiliser use is restricted to the growing of cash crops. When the pattern of fertiliser consumption on wet land is examined it is found that the major concentration is in those areas which have reliable canal irrigation - Thanjavur, Coimbatore and South Arcot. Other areas which have a high proportion of wet land with fertiliser applied are the districts with well irrigation - parts of North Arcot, Salem, western Ramanathapuram and Madurai. It is evident from the maps showing spatial patterns of fertiliser use that there were significant regional contrasts in the adoption of this component of the "new technology".

Figure 4.9 Percentage of wet land with fertiliser applied

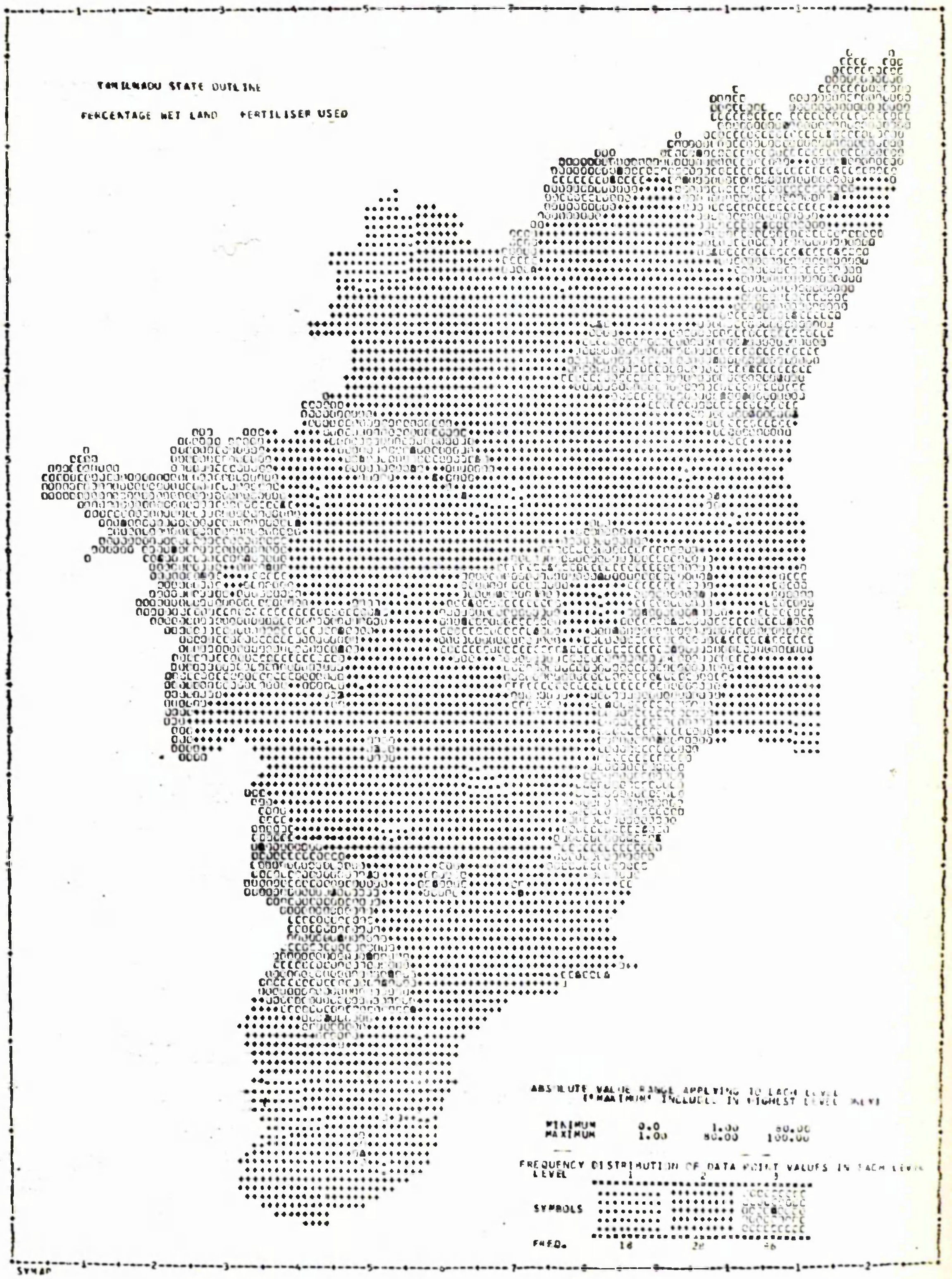
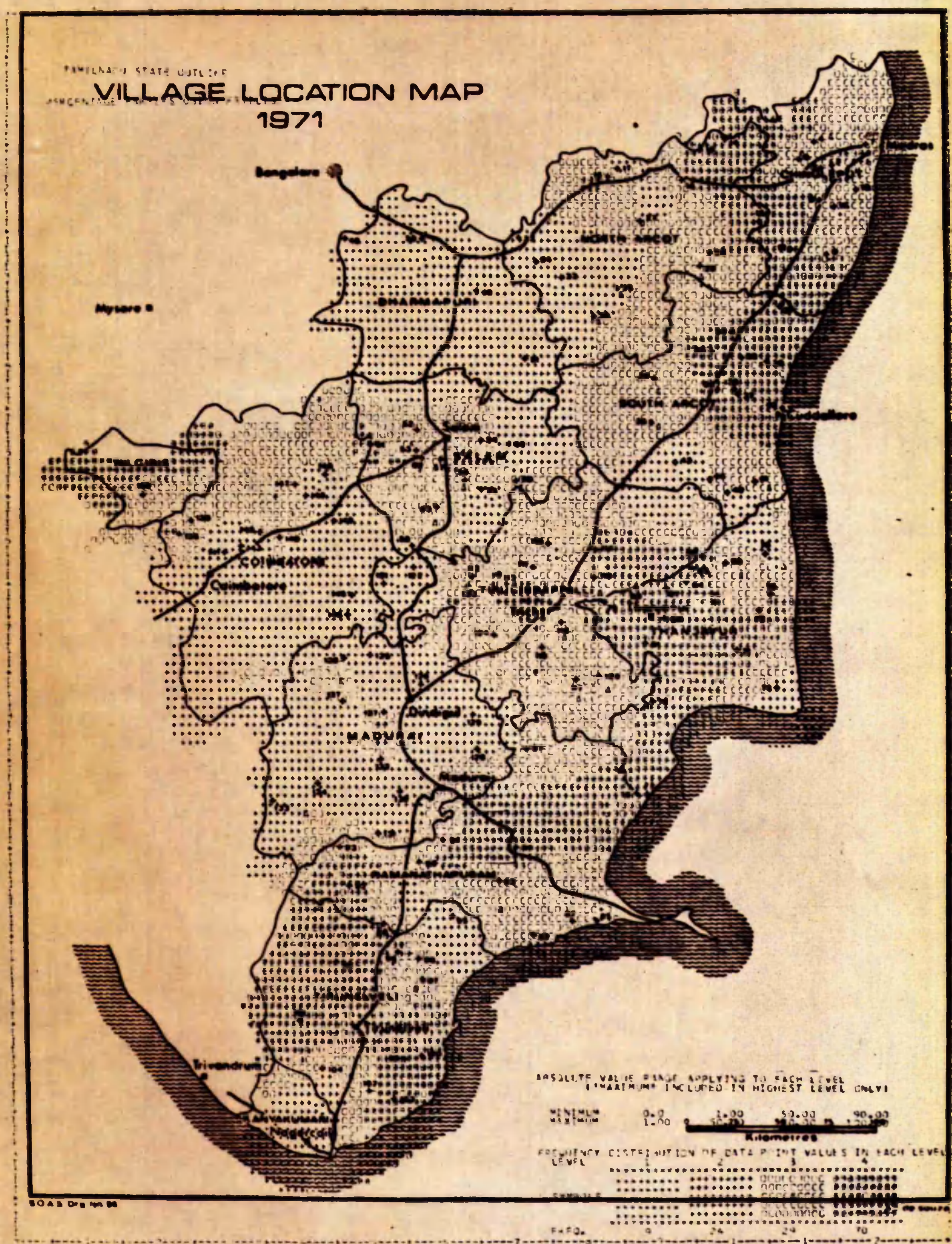


Figure 4.10 Percent of farmers using fertiliser



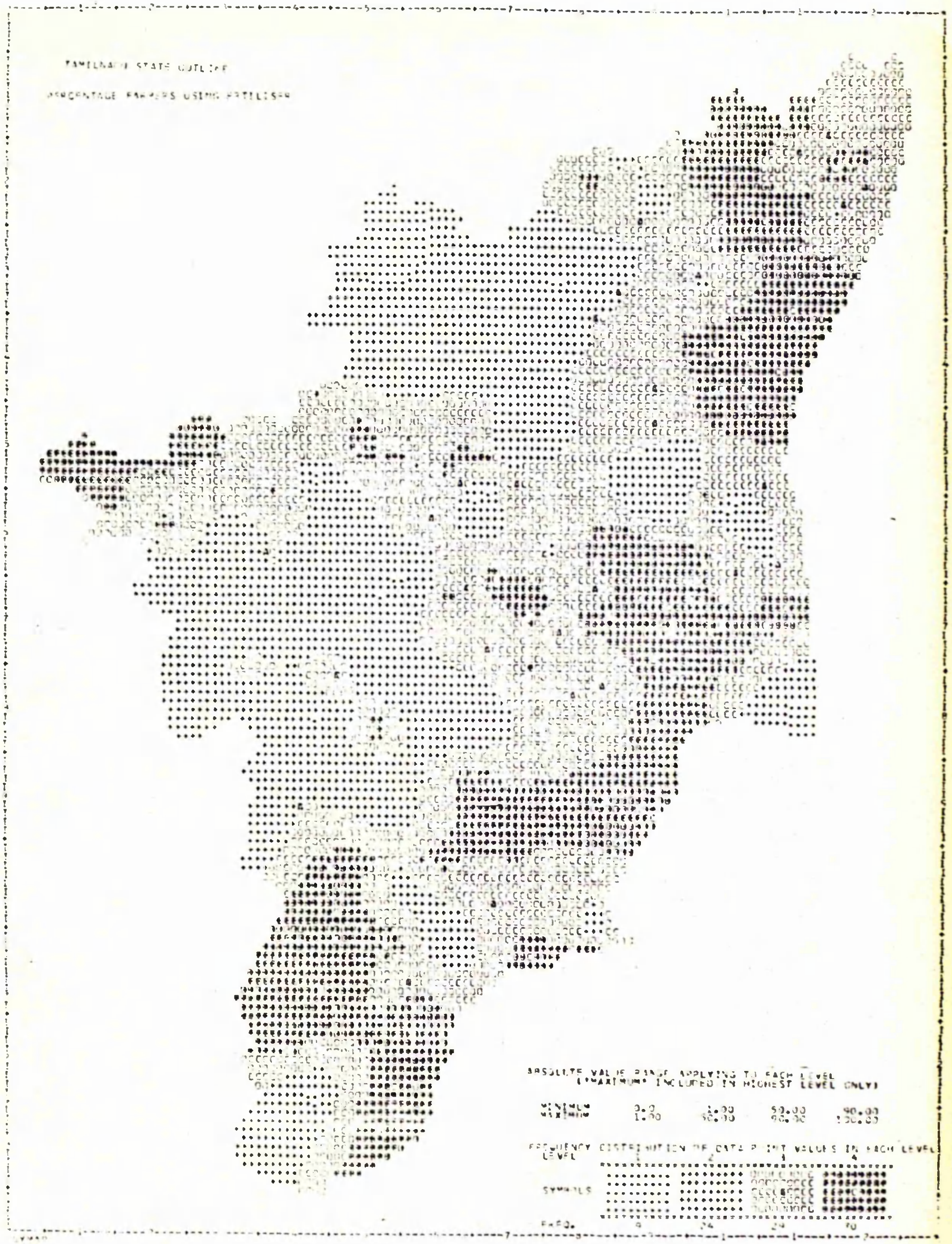

TAMILNADU STATE OUTLINE
PERCENTAGE FARMERS USING FERTILISER
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
MINIMUM 0.0 1.00 50.00 90.00
MAXIMUM 1.00 50.00 90.00 100.00
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
LEVEL 1 2 3 4
SYMBOLS
FREQ. 9 24 24 70

Figure 4.11 Average expenditure on fertiliser: main crop

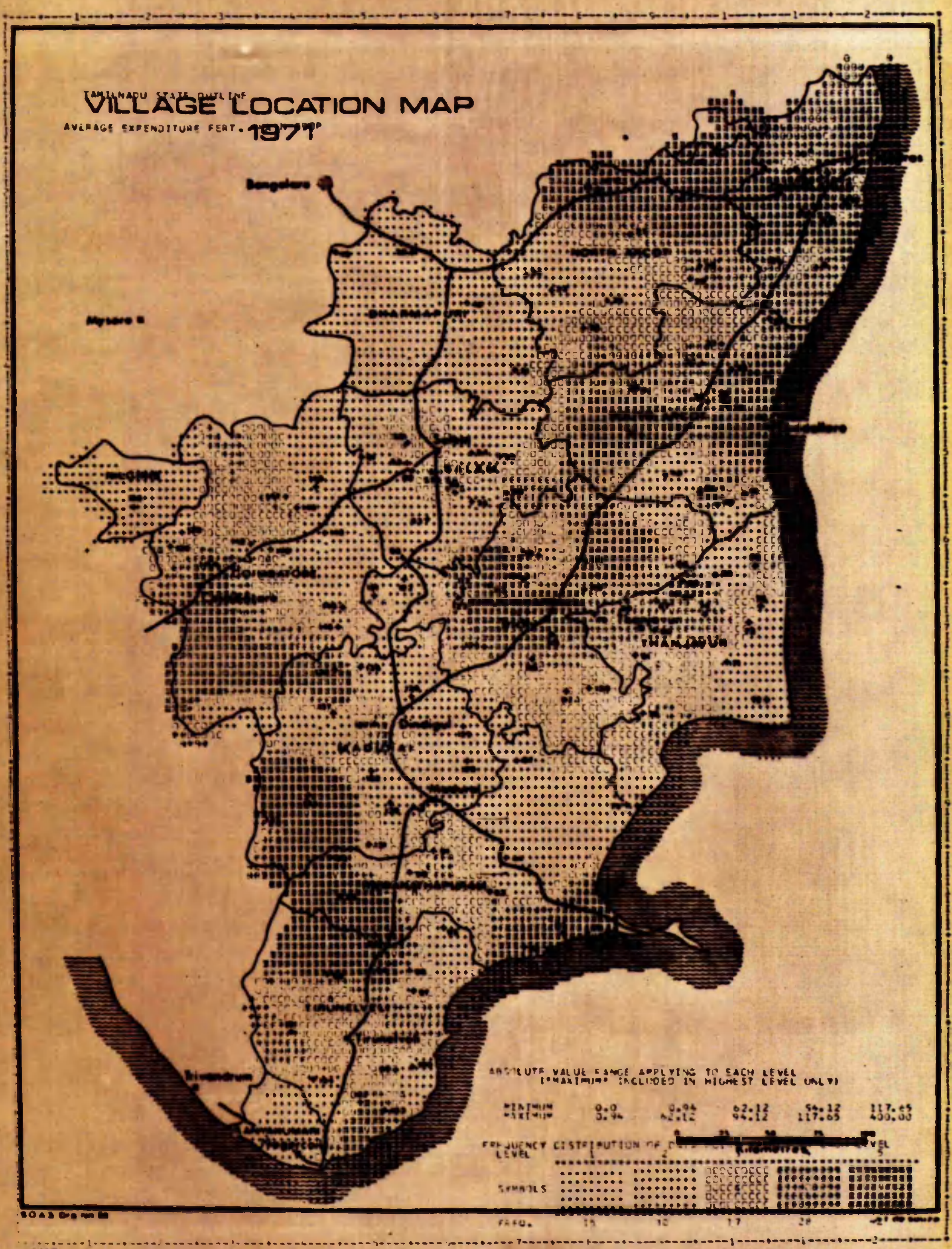


Figure 4.11 Average expenditure on fertiliser: main crop

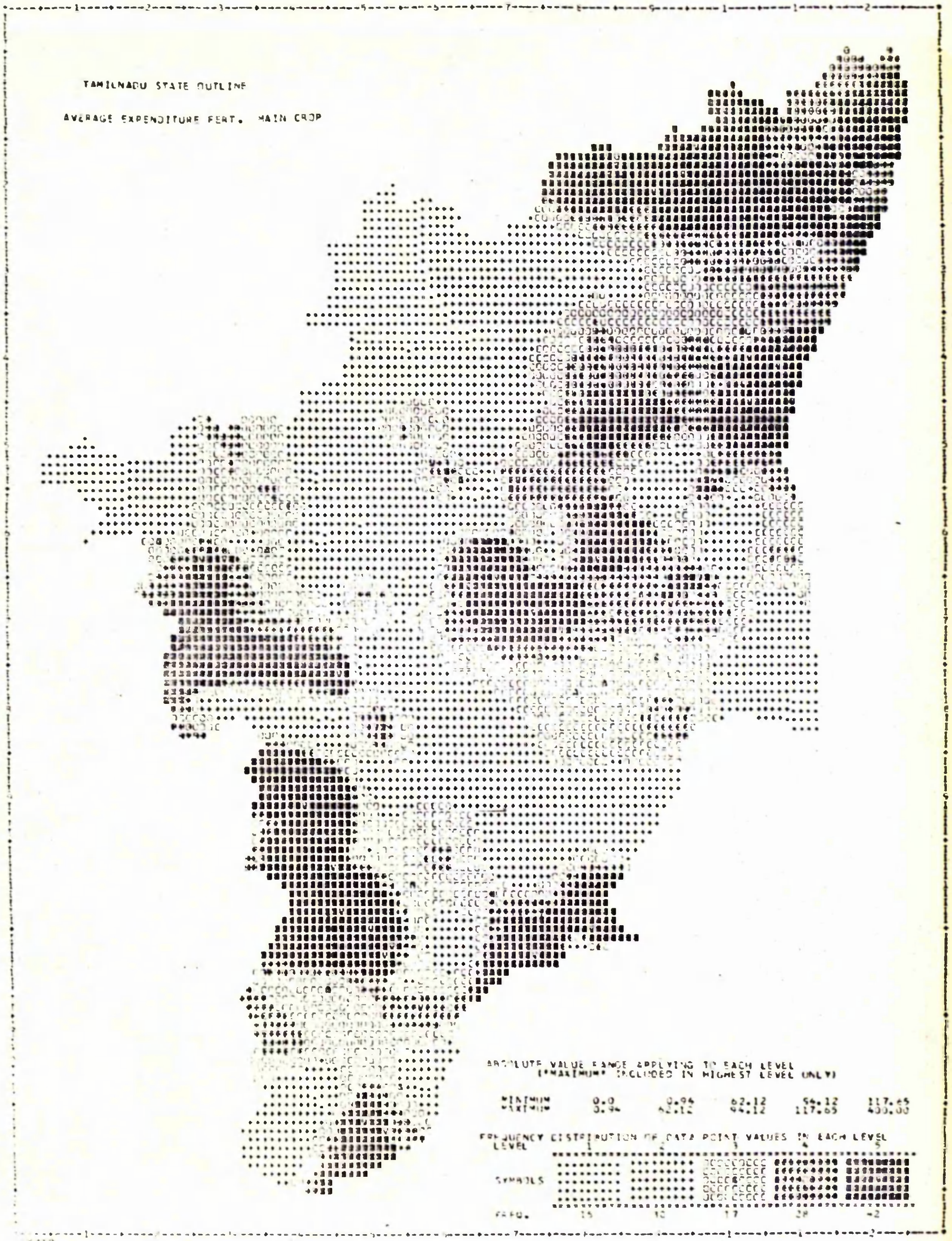
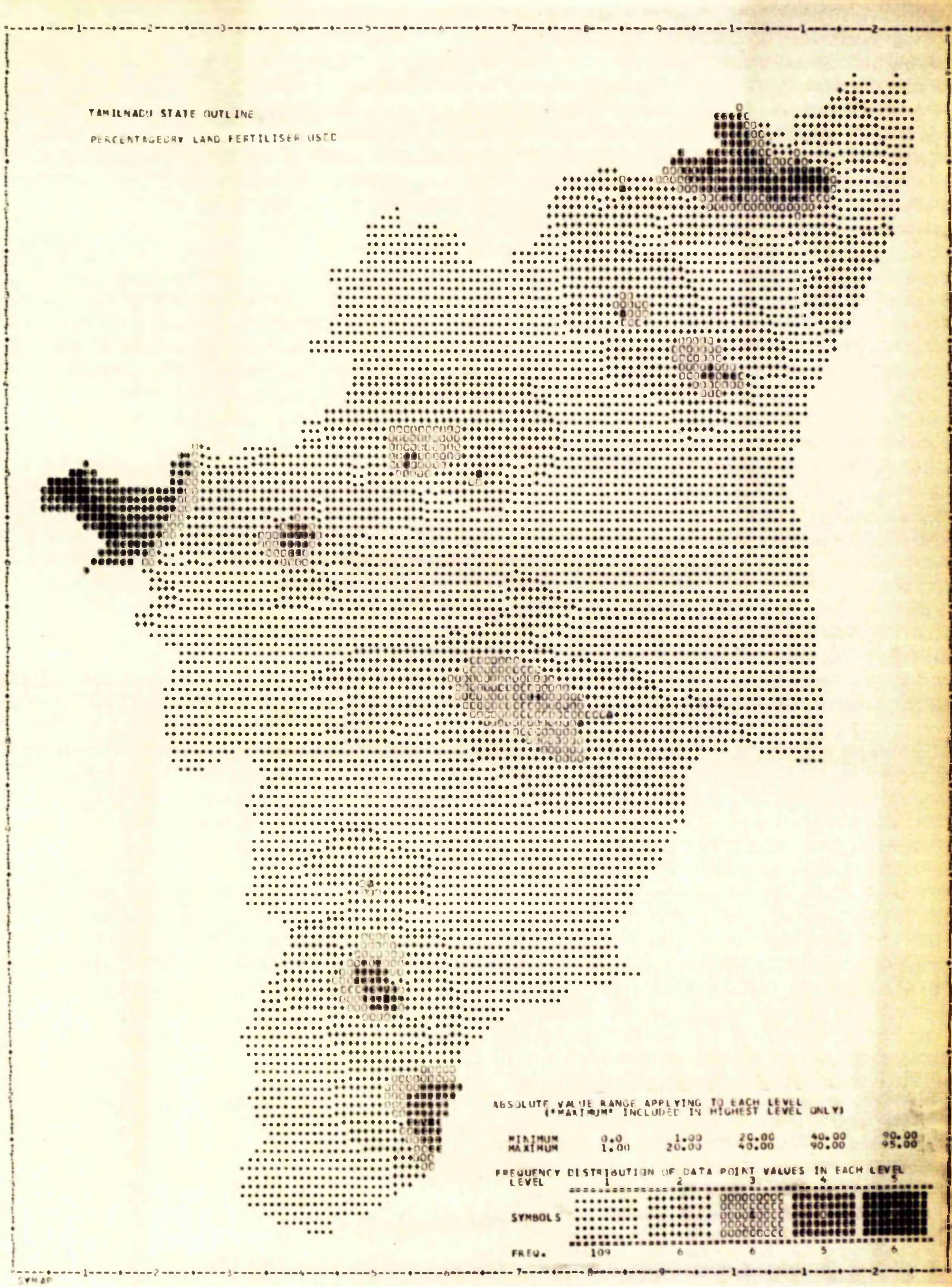


Figure 4.12 Percent of dry land with fertiliser main crop

Figure 4.12 Percent of dry land with fertiliser main crop



4.2.c High yielding varieties: High yielding varieties[1] were available for all the major food grain crops grown in Tamil Nadu by 1971, although some had only just been produced. These were distinguished from " improved " varieties, which had disease and pest resistant qualities, but which under normal conditions did not produce strikingly higher yields than purely local varieties.

By 1971 several different high yielding strains of food grains had been introduced. Rice strains from the International Rice Research Institute of the Philippines (IR5, IR8, IR20), and from the results of cross-breeding experiments within India (ADT 27, CO29, and Karuna) had all begun to be made available, though some were still only experimental. Cholam (sorghum vulgare) and other millets such as cumbu (or bajra) , crops that are found almost exclusively on the unirrigated land, both had high yielding strains available (Figure 4.13) - CSH 1 and CO 19 for cholam and HB 1 for cumbu.

Far the most important of these were the several strains of rice. In 1966-67, which marked the start of the so-called " green revolution ", it was estimated that 0.21 million hectares were sown to high yielding varieties of paddy. By 1971 the Government estimated that this figure had risen to 1.8 million hectares, or just over half the total area sown to paddy. The evidence of the survey carried out for this study suggests that this was a considerable over-estimate, a view which is supported by the

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1. Hutchinson (1970) argues that the term " high yielding varieties " is misleading and should be replaced by the term " highly responsive varieties ". While the reasons for such a change in nomenclature are clearly valid, the widespread use of the former term in official literature makes its continued use in the context of the present study desirable.

Figure 4.13.a High yielding variety of Cholam (CSH 1) Coimbatore District

Figure 4.13.b Transplanting High yielding variety of paddy (IR 8): Thanjavur District

more recent survey carried out by the Cambridge/Madras study (1974). Even so there is no doubt that a rapid expansion in the area sown to high yielding varieties took place in a short time period. Regionally the greatest concentration of effort and of new technology was in Thanjavur, traditionally regarded as the granary of South India. Well favoured areas of Chingleput, South Arcot, Coimbatore and North Arcot also saw the introducti n cf new seeds on a significant scale. The Fourth Plan for Tamil Nadu stated that in accordance with the policy of selective investment in agriculture efforts to encourage the introduction of high yielding varieties would be concentrated in the irrigated parts of four districts in addition to Thanjavur : North and South Arcot, Tiruchirapalli and Kanyakumari. Rs 79.5 lakh was budgetted for the pr ramme, and it is noteworthy that the key factor in the selection of areas to benefit was that they should have assured irrigation (p.40).

Inevitably with official policy aimed at concentrating resources in this way introduction in other districts of new high yielding varieties was very limited. The new varieties of millet needed irrigation to be successful, and thus their impact was extremely marginal. The high yielding varieties of cholam produced at the Coimbatore Agricultural Research Centre were being slowly introduced in parts of Coimbatore and Salem, but on an experimental basis. Furthermore there was evidence in some areas where high yielding seeds had been introduced - both millets and rice - that farmers were reverting to local varieties. This was particularly noticeable in the northern taluks of Madurai district and the south-western taluks of Tiruchirappalli district. This reversion was largely the result of the failure of the crop

Figure 4.14 Percentage of wet land with high yielding varieties

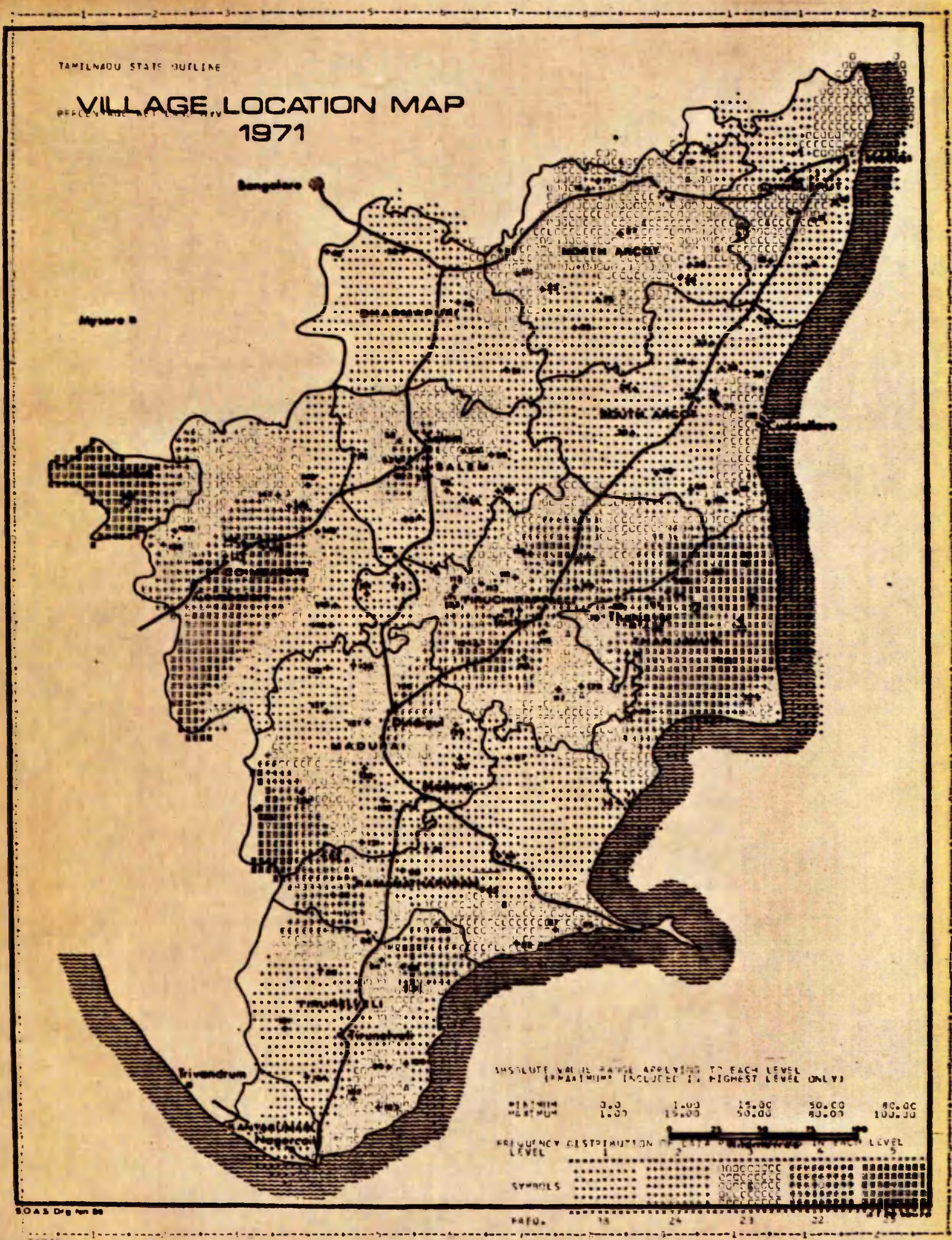


Figure 4.14 Percentage of wet land with high yielding varieties

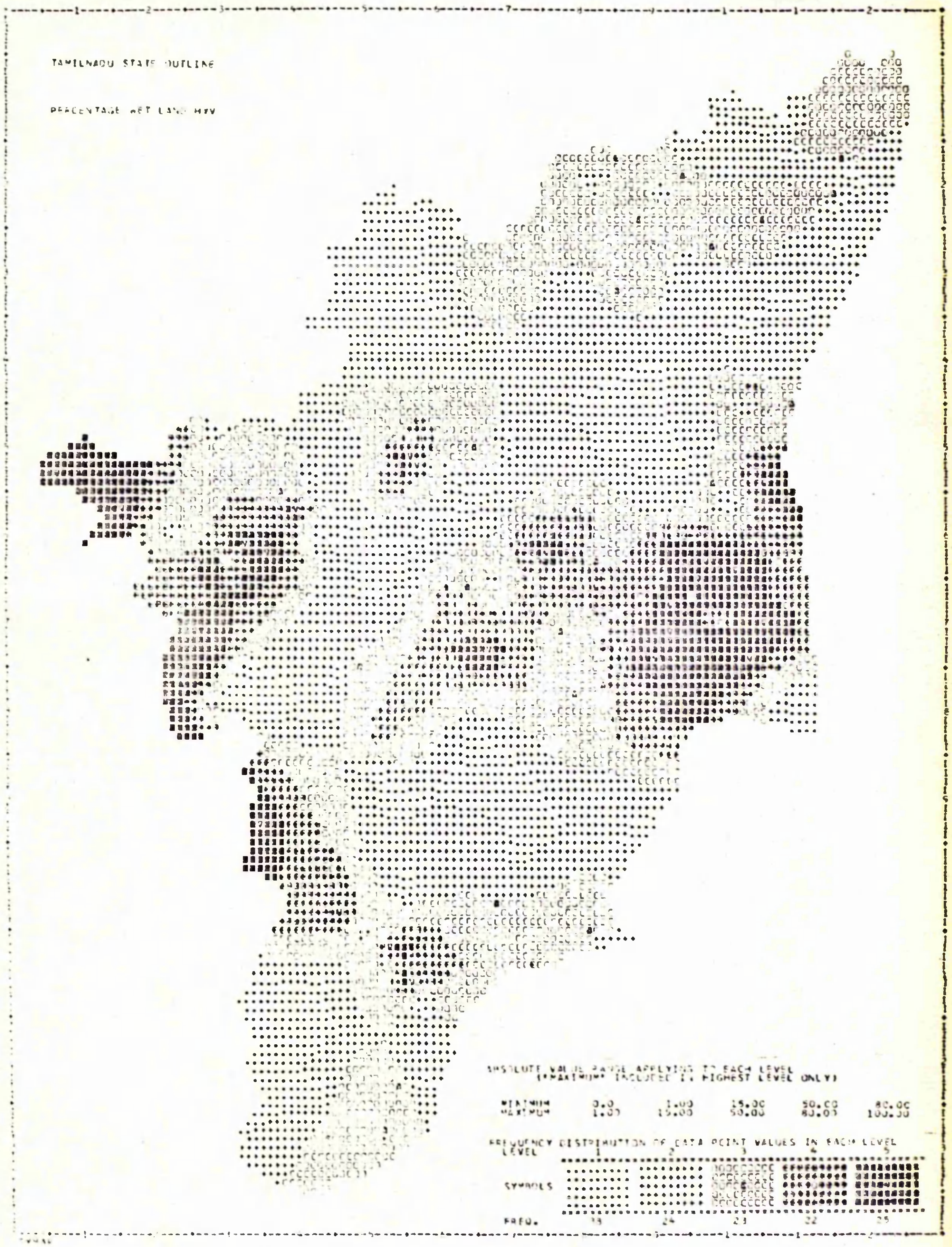
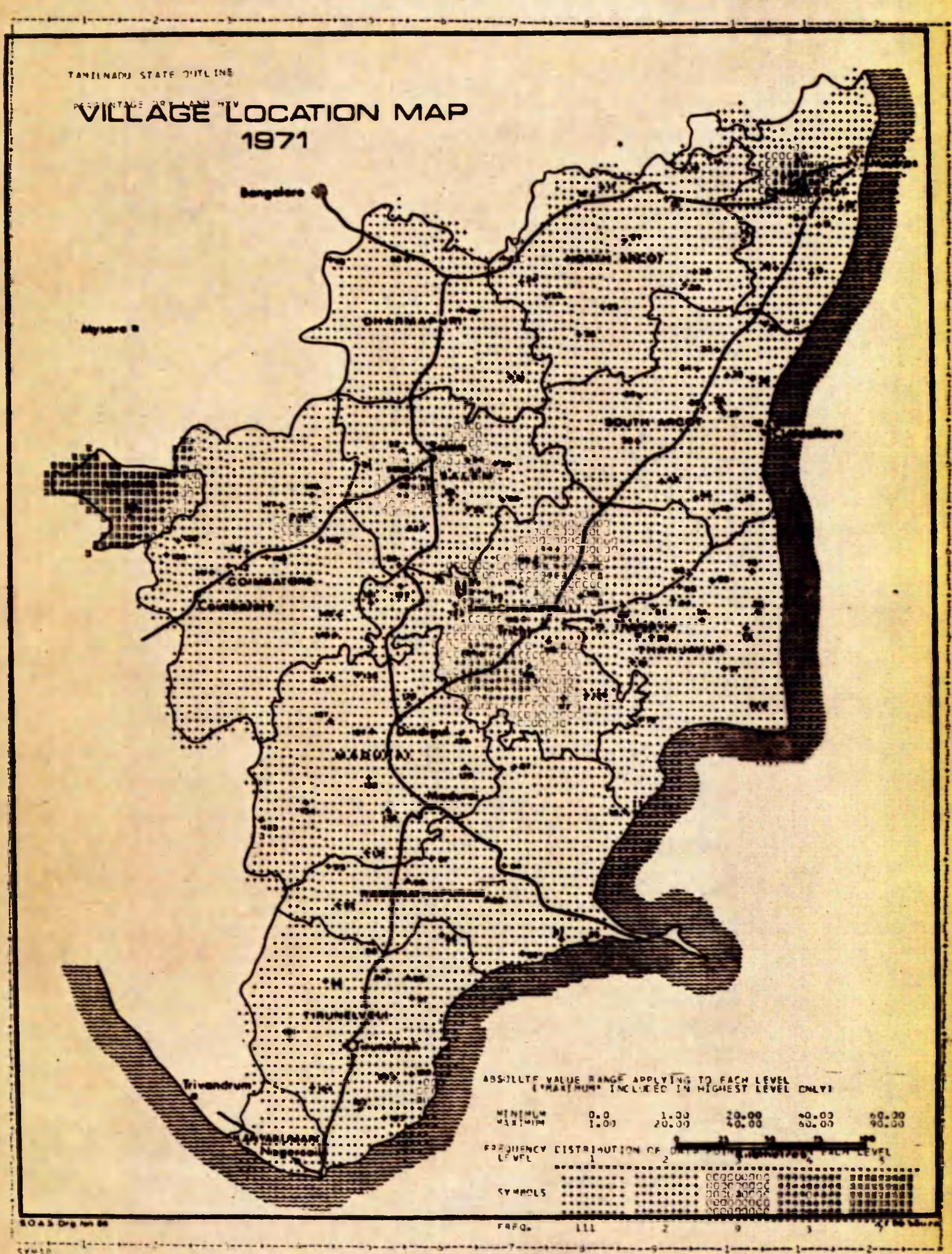
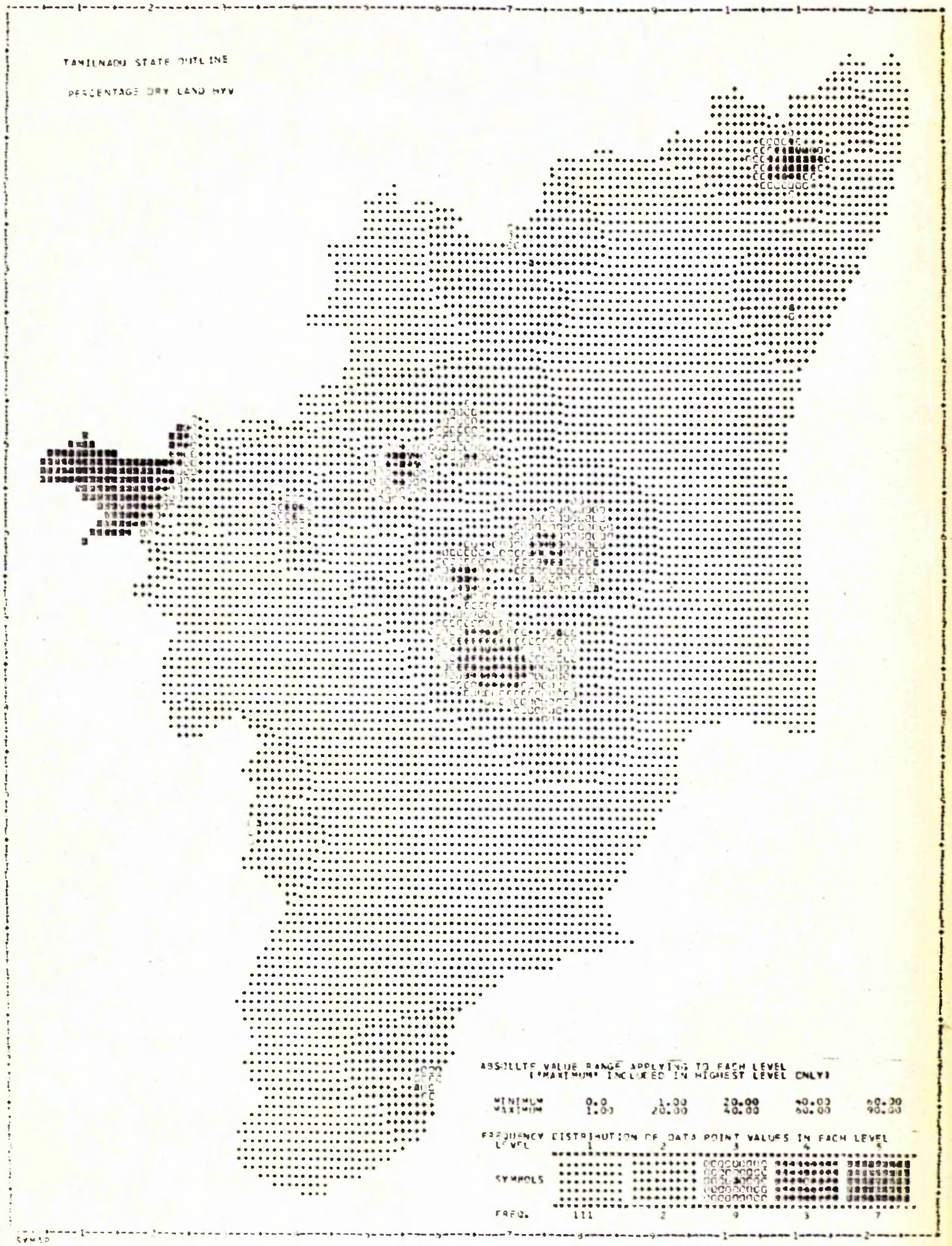


Figure 4.15 Percent of dry land with high yielding varieties



yielding varieties



to withstand pest attack.

Figure 4.14 illustrates the adoption pattern of high yielding varieties in the villages. They show very clearly the strength of the contrasts between the regions. It should be noted that the basis of the class divisions is the median and inter-quartile range. In the top group of villages over 75% of farmers had adopted high yielding varieties, and in the second class between 30% and 75% had introduced them. The pattern of concentration of Class 1 shows it to be restricted to Thanjavur, parts of Tiruchirappalli and the Nilgiri Hills, and parts of Madurai. The distribution of villages in which fewer than 30% of farmers had adopted high yielding varieties is more spread out. The arid south-eastern part of Tirunelveli and Ramanathapuram, western South Arcot and the bordering regions of North Arcot, and coastal Chingleput and the inland district of Dharmapuri all come into this category. The pattern with respect to the percentage of farmers using high yielding varieties as their second crop is predictably much simpler, reflecting the almost entire absence of double cropping on a significant scale outside Thanjavur . The subsequent two maps relate to the proportion of wet and dry land respectively sown to high yielding varieties as distinct from the proportion of farmers using high yielding varieties. While the overall pattern is similar, the latter maps reinforce the argument above concerning the absence of high yielding varieties on dry land.

On the input side of the capital sub-system the forces leading to regional inequality inherent within the physical sub-system have been compounded by irrigation developments both over the longer term and since the inception of planning. New developments in North Arcot, Coimbatore and Tirunelveli have opened up some areas which formerly were very backward, but in general the contrasts between irrigated and unirrigated lands have been increased by the introduction of technological innovations dependent for their success on the availability of an assured water supply. This fact would lead one to expect similar regional patterns of development in terms of the outputs from the capital sub-system that is the crop yields. These are examined below.

4.3 Outputs

Traditionally paddy has always been the most important and the most highly valued crop in Tamil Nadu. Its importance is reflected in the proportion of the total cultivated area sown to paddy. Between 1951 and 1971 this rose from 1.7 million hectares to 2.68 million hectares The area sown to millets on the other hand remained constant or declined slightly. In 1951 it was 1.71 million hectares, fluctuating slightly around this level until 1971 when it was 1 69 million hectares Altogether foodgrains covered 4.37 million hectares or two thirds of the cropped area in 1971.

The major differences in cropping pattern within the State reflect the wet land - dry land dichotomy. In every district except Coimbatore over half the irrigated land was sown to paddy; the mean figure for wet land under paddy was over 75%, ranging from 39% in Coimbatore to over 98% in Thanjavur. The intensity of cropping varied considerably, and in 1971 it was only in the districts of Thanjavur and South Arcot that double or triple cropping w s at all widespread. Cash crops in general have a very limited share of the irrigated land, sugar cane being an exception in this respect.

The cropping pattern on dry land is quite different. Millets predominate, and in 1961 covered 47% of the dry land. Oilseeds were sown on a further 26% and pulses on 11%. In Chingleput and Kanyakumari, the two districts outside the Nilgiris with the highest rainfall in the State, unirrigated paddy was grown extensively. As in tank fed areas, however, only one crop was grown per annum. Apart from the relatively recent expansion of sugar cane production on irrigated lands in Coimbatore, Tiruchirappalli, Salem, South and North Arcot, most of Tamil Nadu's cash crops are grown on dry land. None of these crops increased their acreage between 1961 and 1971, the total area under non-food crops declining from 1.80 million hectares to 1.79 million hectares.

With the statistics on the area sown to different crops in mind it is possible to turn to the figures relating specifically to changes in output over the perid 1951-1971. A caveat needs to be added at this point conce ing the accuracy of the data. Perhaps nothing more amply justifies Lord Melbourne's famous epigram "Lies, damned lies and statistics " than the official statistics available of agricultural output. Most of India's agricultural statistics have been open to question (Thorner and Thorner 1961, Farmer 1975), and it would be unwise to place too great a stress on small points of detail. Even allowing for the necessary margin of error, however, it is clear that output of all the major crops rose significantly during the period between 1951 and 1971. In that twenty year period the production of paddy went up by 65% ; cholam by 135%; cumbu by 33%; and the cash crops cotton and sugar cane by 20% and 33% respectively.

The size of this increase looks sufficiently large to brook no argument, but the need for caution is evident from Table 4.2.

Two major points emerge from this table. First, it is evident that there were considerable fluctuations in yield corresponding to good and bad harvest after 1951. Secondly, the growth pattern through time varies from crop to crop, and the base levels from which the percentage growth is recorded were also very unequal. These indicate the need for a long term perspective in viewing the process of agricultural change, a perspective which Byres (1972) has also shown to be necessary in any discussion of the "green revolution". Attention must also be paid to the regional implications of the output figures.

Unlike the States of north-western India, in Tamil Nadu the effort to increase agricultural production has been spearheaded by efforts to improve paddy yields. Since 1951 this crop has increased its share of the total foodgrain and total crop production, but it has also been subject to considerable fluctuations in yield. Thus between 1968, which was a bad year for grain production but the year in which high yielding varieties were introduced, and 1971, yields per hectare rose by35% to 1,962 kg. However, by 1961 yields f paddy per hectare had already reached 1,540 kg., only 27% lower than tose obtained in 1971. This in turn represented an increase of over 40% on the yields obtained 10 years earlier in 1951. It is evident from the long term secular trend of growth that paddy production was increasing long before the high yielding varieties programme was introduced.

Table 4.2

District-wise agricultural activity in Tamil Nadu 1971

	Area	Gross Cult. area	Paddy	Cholam	Cumbu	Ragi
1	1,230,223	635,000	274,000	35,875	17,102	30,586
2	1,039,883	608,000	331,000	34,491	54,982	19,802
3	862,005	459,000	70,000	83,109	50,646	32,374
4	962,914	459,000	51,000	54,433	13,161	85,631
5	166,827	114,000	62,000	214	180	23
6	1,242,762	646,000	278.000	13,890	50,687	29,953
7	968,245	849,000	656,000	1,490	1,076	2,006
8	824,798	437,000	327,000	810	5,397	22,652
9	1,560,374	831,000	103,000	189,553	54,529	35,263
10	1,425,850	808,000	235,000	137,124	97,790	14,336
11	1,141,621	541,000		28,129	76,654	8,941
12	1,261,243	625,000	149,000	138,575	26,249	9,080
13	254,475	54,000	4,000	136	5	1,471

The district codes are as follows: 1. North Arcot 2. South Arcot 3. Salem 4. Dharmapuri 5. Kanyakumari 6. Ramanathapuram 7. Thanjavur 8. Chingleput 9. Coimbatore 10. Tiruchirappalli 11. Tirunelveli 12. Madurai 13. Nilgiris.

(Data from Tamil Nadu Agriculture 1971)

It remains true that in the middle 1960's, when disastrous har ests wrecked the Third Five Year Plan and caused the Fourth Plan to be delayed in its implementation, a limit to ever increasing yields appeared to have been reached. Traditional varieties of seed had been shown to be incapable of capitalising on the higher levels of soil fertility achieved through the application of chemical fertilisers The appearance of new varieties of seed which could take advantage of this fertility came at a critical moment if the apparent ceiling to production were to be lifted.

The regional implications of this technological breakthrough were not without significance. The new technology of Indian agriculture brought benefits primarily to those regions which had the infrastructure described in the earlier sections of this Chapter. In Tamil Nadu there was one major contrast with the other areas of India that underwent a period of rapid agricultural change at the same time in that it was those areas with a high percentage of paddy which benefitted most. This was simply a reflection of the fact that the most fertile land and by far the highest proportion of irrigated land in the State were sown to paddy. These regions therefore fulfilled the conditions of high promise regarded as essential by the Government as pre-conditions to intensive agricultural development.

The picture with regard to millets is very different, both in terms of the trends of growth in production through time and in terms of their regional implications. Like paddy yields, yields of millets rose steadily through the 1950's. Cholam yields, from a very low per hectare yield of 314 kg. in 1951-52 rose to 818 kg per hectare in 1959-60. In a similar period yields of cumbu rose from 493 kg. per hectare to 677 kg. per hectare, although the highest yields for cumbu were recorded in 1962-63 rather than two years earlier as was the case for cholam. In the following decade the yields of both crops stagnated or declined, and unlike paddy showed no signs of a resurgence after 1968. Thus by 1971 the high yielding varieties programme had had no effect on the yields of unirrigated foodgrains, and no other measures had then been taken to boost their production. The true contrast between irrigated lands and unirrigated lands is only fully realised however when it is seen that even those areas which did have high yields of millet were those in which the crop was an irrigated crop, making them quite atypical among millet producers.

Cash crops also showed unimpressive improvements in yield after 1960. Yields of groundnut, the most important cash crop for Tamil Nadu in terms of area, declined from 1002 kg per hectare in 1951 to 916 kg per hectare in 1971. Yields of cotton during the tw nty year period rose by only 30%. There can thus be no escape from the conclusion that Tamil Nadu's agricultural development has been both structurally and regionally unbalanced.

4.4 Conclusion

The foregoing analysis has highlighted the manner in which the changes in the capital sub-system have tended to reinforce the regional contrasts in the physical system discussed in Chapter Three. Government policy in the field of agricultural development has had three main planks; the improvement and extension of irrigation works, the implementation of land reform measures and the development of an agricultural extension service. It is the first of these that has been discussed in this Chapter, and the evidence of the analysis points to the conclusion that irrigation has been a critical factor in the regional patterns of agricultural change. It has been shown to have been a fundamental precondition for the spread of modern agricultural technology, and the heavy emphasis on this aspect of agricultural change particularly at the end of the 1960's tended to increase the disparities between wet and dry areas. Even allowing for the importance of garden land to some unirrigated areas at a macro-level the contrast remains a significant one. In the absence of special measures to counteract the disadvantages which the lack of irrigation facilities implied, the period preceding 1971 was characterised by a growing contrast between Tamil Nadu's irrigated and unirrigated regions.

Although the growing contrasts which have been outlined reflect the influence of the physical environment as well as of the innovations of the capital sub-system, agricultural development has also been affected by the social and economic environment in which it takes place and from which it is clearly impossible to separate it. This social and economic environment and its relationship to regional patterns of development is the subject of the next Chapter.

CHAPTER FIVE

The Social and Administrative Environment of Change

5.1 Introduction

It is impossible to interpret changes in the regional patterns of economic activity in Tamil Nadu without reference to the wider social context in which such development takes place. In this Chapter the labour and administrative sub-systems are examined, for both have played an important role in shaping the regional patterns of change.

The importance of some elements of social structure for development remains at the centre of dispute. While Kapp (1966) for example has explored the relationship between Hinduism and economic change, its significance is still in doubt. Similar uncertainty surrounds the role of caste. From the early reports of the gazetteers up to the recent accounts of Mayer (1965), Epstein (1957,1973) and Beteille (1969), caste had been seen as fundamental to the organisation of village life. Its influence over a range of activities and economic choices has been shown to be of paramount significance. Yet again there is some dispute as to the extent of caste's influence over the nature and rate of economic development and regional change.

That the possibility of a relationship between caste and development is not examined directly in this Chapter does not imply that it is felt to be unimportant but that in a study such as this such an analysis is impossible to 'operationalise'. However, it is shown in Chapter Seven and Chapter Eight that caste may be used as a control variable in the subsequent analysis.

5.2 The Labour Sub-System

Five components of the labour sub-system are examined below, and the links between them are shown diagrammatically in Figure 5.1. The components are:

a. worker participation rates
b. occupational structure
c. education and levels of skill
d. social systems and labour utilisation
e. health

5.2.a Worker participation: Tamil Nadu has a low worker participation rate compared to that of industrialised countries. In 1971 it stood at 35.78% of the population (Census of India 1971). This low rate reflects two factors. First, the high birth rate over the last twenty years and greatly reduced infantile mortality has resulted in a bottom heavy age pyramid. Although children start work very young, especially in the rural areas, dependency rates remain at a very high level. Secondly, worker participation rates among women are generally very low. The highest level of female worker participation rates was found in the Nilgiris where plantations offered scope for female employment on a significant scale. In the Nilgiris the female worker participation rate was 262:1000, while in six of the districts the figure was as low as 150:1000.

Even allowing for a considerable margin of error in the Census data the contrasts between the districts are suggestive. The highest worker participation ratios are found in Coimbatore, Salem and the Nilgiris with 409:1000, 395:1000 and 388:1000 respectively. At the other extreme come Madras with 282:1000, Kanyakumari with 287:1000 and Thanjavur with 334:1000. As suggested above, there are pronounced contrasts between the rural and urban areas, with significantly higher figures in rural areas. For Tamil Nadu as a whole the urban worker participation rates average 302:1000 while the rural rates average 382:1000.

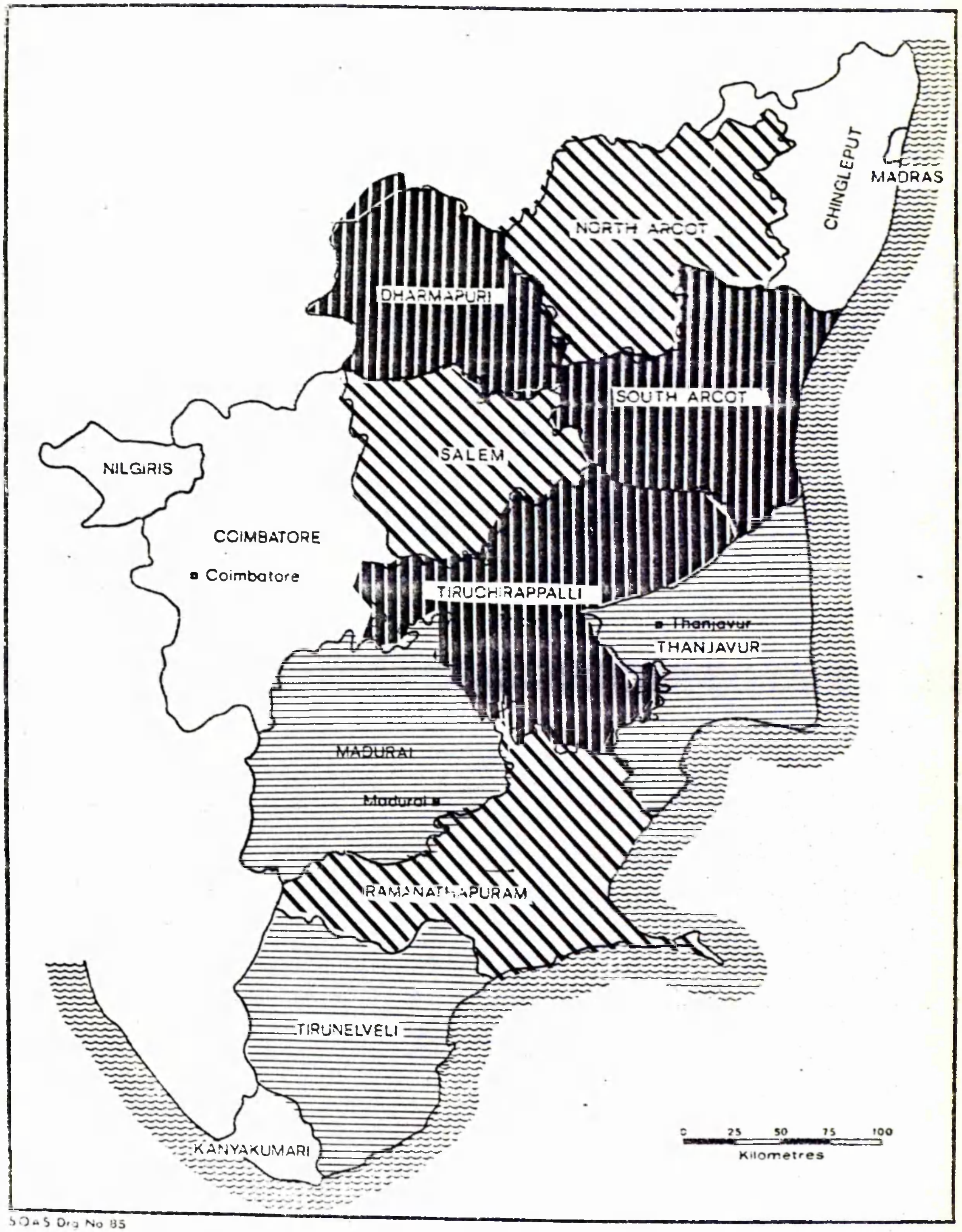
The factors which govern worker participation rates at the district level remain obscure. The urban-rural contrasts may be ascribed in part to social custom, but a major contributing factor may lie in the distribution of scheduled castes which is heavily biased towards the rural areas. In the rural areas of Tamil Nadu the scheduled castes made up 21.06% of the population while in urban areas they represented only 10.15%. This has a bearing not only on the urban rural contrasts themselves but indirectly through their effect on female worker participation. Caste Hindu women have been strongly discouraged from working in traditional Hindu society, a feature of social life which is also characteristic of middle class Christians and Muslims. Although this pattern is now changing rapidly among younger women in the biggest cities the change had not progressed sufficiently in Madras by 1971 to make its impact on the statistics.

5.2.b Occupational structure: The occupational classification in the Indian Census is notoriously unreliable (Thorner and Thorner 1962, Myrdal 1968, Badrinath 1971). On the one hand classifications adopted by the Census have not been stable through time, so that comparisons between 1951, 1961 and 1971 are often difficult or impossible. On the other hand the accuracy and reliability of the data themselves are open to question.

Despite these difficulties, which become even more acute in relation to tenancy and land ownership, the major characteristics of occupational structure within the districts are decipherable.

Every district in the State has the major part of its workforce engaged in agriculture. Figs.5.1/5.2 showthe distribution of cultivators and agricultural labourers among the districts. 62% of Tamil Nadu's workforce is engaged in agricultural activity. Of these, 4.5 million are classified as agricultural labourers and 4.6 million as cultivators. The districts are far from uniform in their share of labourers and cultivators, and in the overall proportion of the workforce engaged in agriculture. At one extreme lies Dharmapuri, where 84% of the workforce is engaged in agriculture. This district is followed by South Arcot with 79% and Thanjavur with 71%. At the other extreme, leaving aside the entirely metropolitan district of Madras and the Nilgiris , come Kanyakumari with 53%, Coimbatore with 55% and Tirunelveli with 56%.

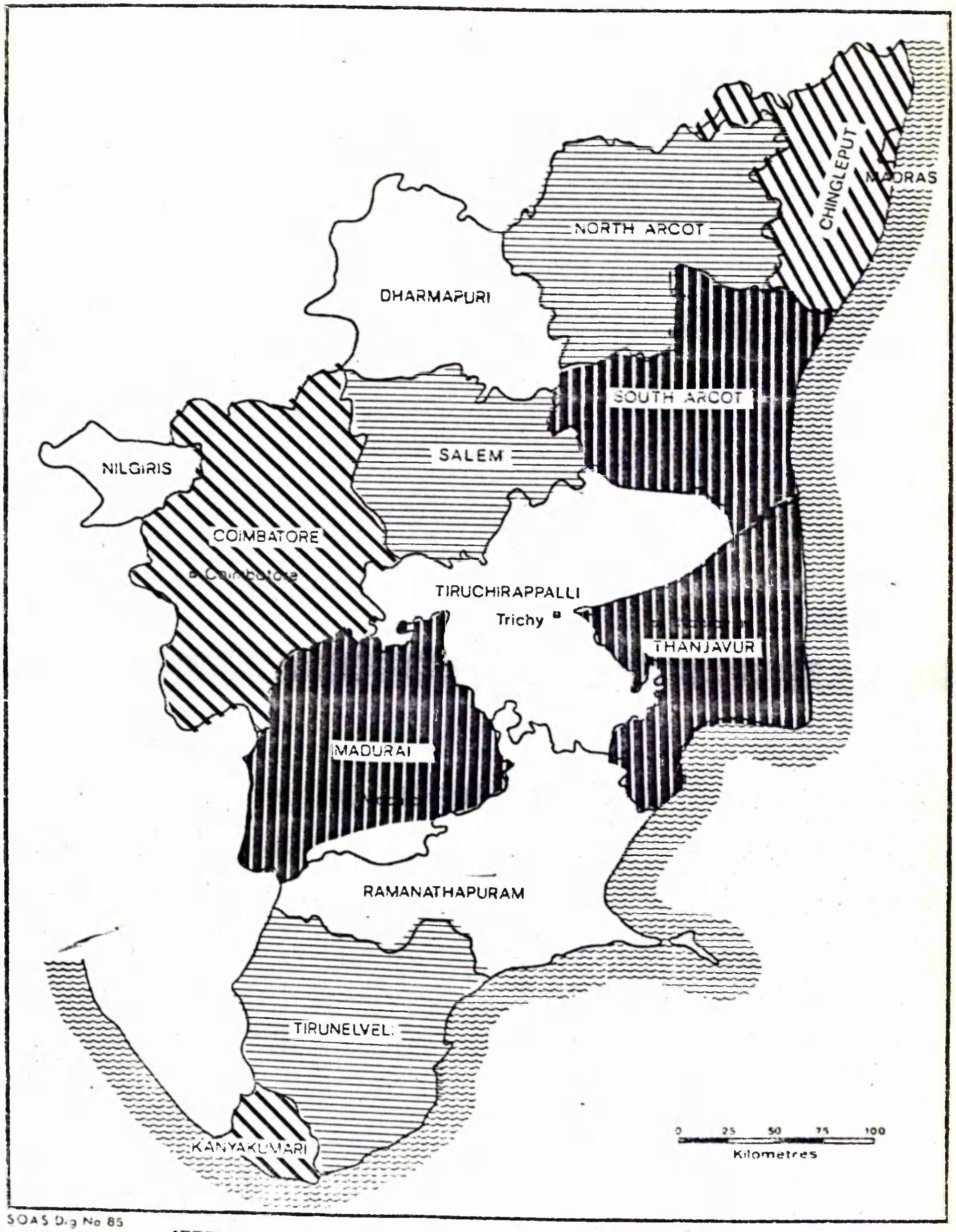
The contrasts which these figures suggest are important from the viewpoint of this study for one reason. In the subsequent chapters the analysis focuses on village level patterns of change. While such village level patterns have wide significance throughout Tamil Nadu the importance of agricultural variables as indicators of economic change clearly varies according to the importance of agriculture within the district. The availability of alternative employment opportunities and alternative sources of income may be expected to be an important factor in the nature and pace of economic change within the villages. Equally the relevance of the agricultural changes discussed in the subsequent analysis is greater in areas with a high degree of dependency on agriculture than in those where a more broadly based economy exists.



SOAS Drg No 85

Over 41% 25% - 34%

35% - 41% Less than 25%



Over 35%

27% - 30%

31% - 34%

Less than 27%

A caveat needs to be added to the general picture of employment presented above. A discussion at the district level inevitably misses contrasts which may be very important at the village level. Thus although the dominance of agriculture is pronounced in all the districts of Tamil Nadu in several regions there are villages which specialise entirely in non-agricultural activities. An example may be found in the spinning and weaving villages of Coimbatore where very little income is derived from agriculture and whole villages are effectively devoted to small-scale industrial activity. Thus at the village level the micro-economic structure is of great importance and may contrast with the macro-economy within which it is set.

Table 5.1 sets out the district-wise distribution of the occupational groups in 1971. While the classifiaction conforms in general terms to that found in many industrial countries, there are some differences. This is particularly true with reference to the tertiary sector. As Myrdal (1968) has pointed out the service activities represented by Category IX are usually very different from those found in industrialised countries. They are generally services of a menial character, and many of those classified in Category IX are almost certainly only semi-employed or unemployed.

The proportion of the workforce active in industry varies markedly from district to district. Bearing in mind that Tamil Nadu is near the top of India's industrial league, some of the districts have shown far more rapid industrial growth than others. By the 1930's both Madurai and Coimbatore were developing textile mills

Table 5.1 District-wise classification of occupational groups

	1	2	%	3	%	4	%	5	%
Chingleput	980,755	238,790	24	330,254	34	50,230	12	112,792	12
North Arcot	1,333,169	510,096	38	416,303	31	54,759	4	92,976	7
South Arcot	1,255,163	523,709	42	464,411	37	24,522	2	43,967	4
Dharmapuri	610,878	349,768	57	160,727	26	8,202	1	12,467	2
Salem	1,182,279	410,544	35	331,347	28	108,393	9	111,900	9
Coimbatore	1,786,460	417,124	23	570,330	32	105,859	6	225,563	13
Nilgiris	191,813	9,451	5	14,406	8	920	-	15,142	8
Madurai	1,453,938	420,324	29	526,238	36	46,406	3	108,319	7
Tiruchirappalli	1,425,869	631,809	44	371,131	26	44,826	3	107,460	8
Thanjavur	1,282,909	374,324	29	541,919	42	31,864	2	53,444	4
Ramanathapuram	1,020,345	371,900	36	275,045	27	58,401	6	90,760	9
Tirunelveli	1,171,516	290,757	25	360,858	31	105,503	9	117,632	10
Kanyakumari	350,494	58,120	17	126,447	36	18,857	5	30,516	9

Key: 1 - total workers; 2 - cultivators; 3 - agricultural labourers; 4 - household manufacturing; 5 - non-household manufacturing. The figures in the columns headed " % " represent the occupational group as a percentage of the total workers in the district.

which have now become of major importance. The original textile industries form a nucleus in these towns for a broadening base of engineering industries which have led to the nick-name for Coimbatore of the Manchester of India - though it must be admitted that the environmental similarity is slight indeed! Table 5. shows very clearly the importance of both large-scale and small-scale industries in Coimbatore, Salem and Tirunelveli. In terms of factory employment Coimbatore has a considerably higher proportion of its labour force in large-scale industrial employment than any other district. However, even Coimbatore has no more than 10% of its labour force engaged in large-scale industry, which brings home forcibly the relatively small contribution that the organised sector of industry makes even in this "industrialised" State.

At the opposite extreme from Coimbatore and Salem are districts such as Dharmapuri, South Arcot and Thanjavur which have 3.3%, 5.5% and 6.7% of their labour force employed in any form of industrial activity. Absence of industrial employment even in the household sector is an indication of the complete dependence of these districts on agriculture. By 1971 industrialisation was responsible for a negligible degree of change in these districts, and thus the changes in agriculture analysed below are virtually a complete index of economic change within them.

To the extent that districts had developed industries the village agricultural base had become decreasingly relevant an indicator of rural standards of living. Although there are signs that by 1971 some regions were becoming more industrialised such developments remained confined to a relatively small section of the population.

5.2.c Educational levels: For reasons of simplicity only one index of educational attainment, literacy, is adopted here. It has been a major plank of Government policy that education is a vital factor in the development process. Commonly success in education has been accounted simply in terms of literacy rates, though the relevance of literacy *per se* to economic development may be questioned. Evidence presented in the subsequent analysis supports the contention of Friedmann (1964) that the correlation between literacy and economic development is far from a simple or straightforward one. At the macro-economic level evidence of the enigmatic nature of the relationship comes from Kerala, India's most literate State and yet at the same time one of the poorest and most backward. Although the relationship between literacy and economic development is unclear some would argue that literacy is one measure of economic development itself. As such, Figure 5. shows the pronounced contrasts between the districts of Tamil Nadu that exist in the degree of literacy as in the other variables relating to the labour sub-system. Madras again stands out at the top as having a higher percentage of its population literate than any other district with 62%. Other districts with high scores are the southern districts of Kanyakumari and Tirunelveli, both of which owe their high literacy rates to the long tradition of mission schooling, and the Nilgiris in the west. All these districts have over 45% of their population enumerated as literates. In contrast Dharmapuri, South Arcot and Salem have the very low literacy rates of 22%, 31% and 31% respectively.

The contrasts are more pronounced among the rural populations than among the urban populations. This can be seen from the inter-quartile range

Figure 5.5 Literates - male

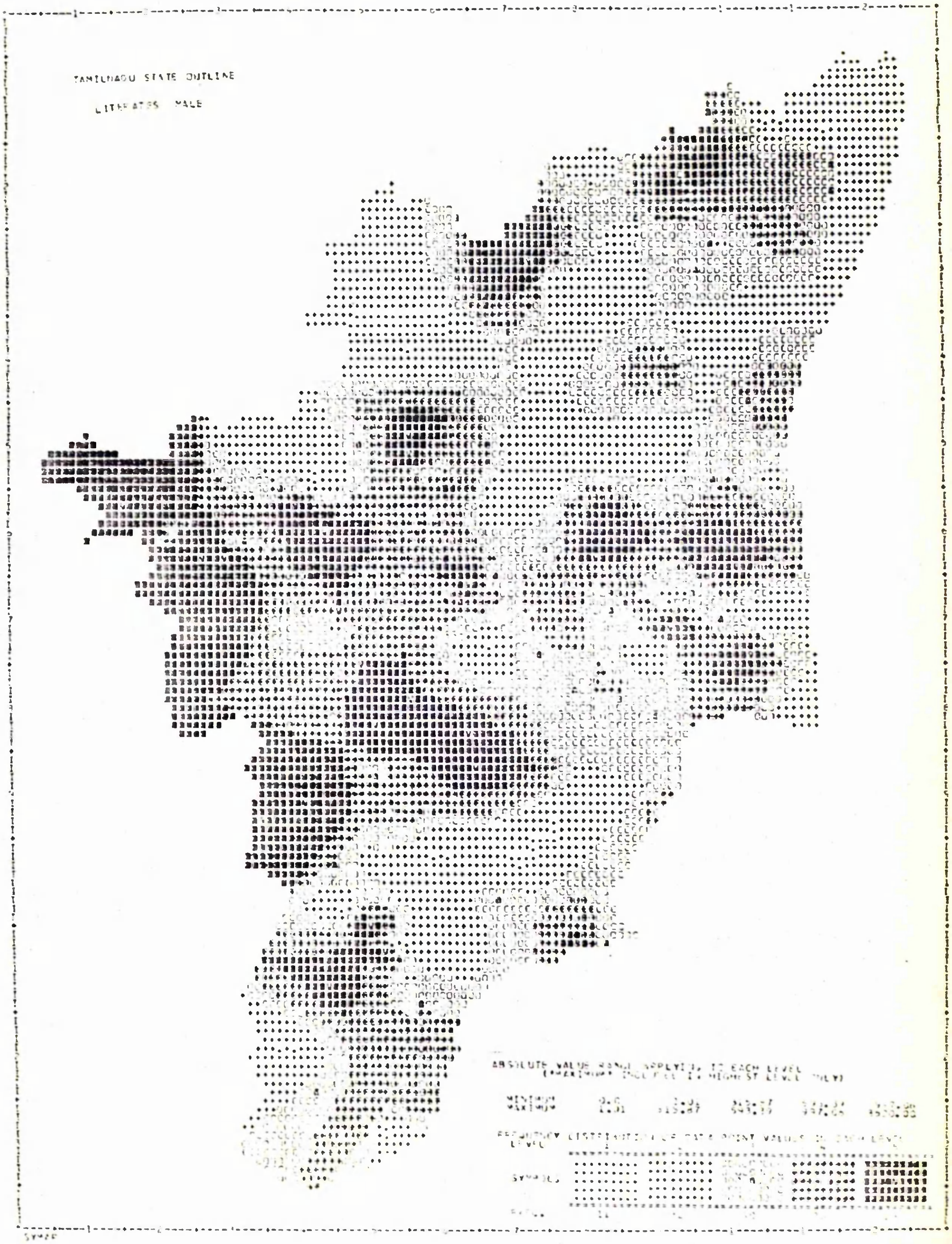


Figure 5.4 Literates - female

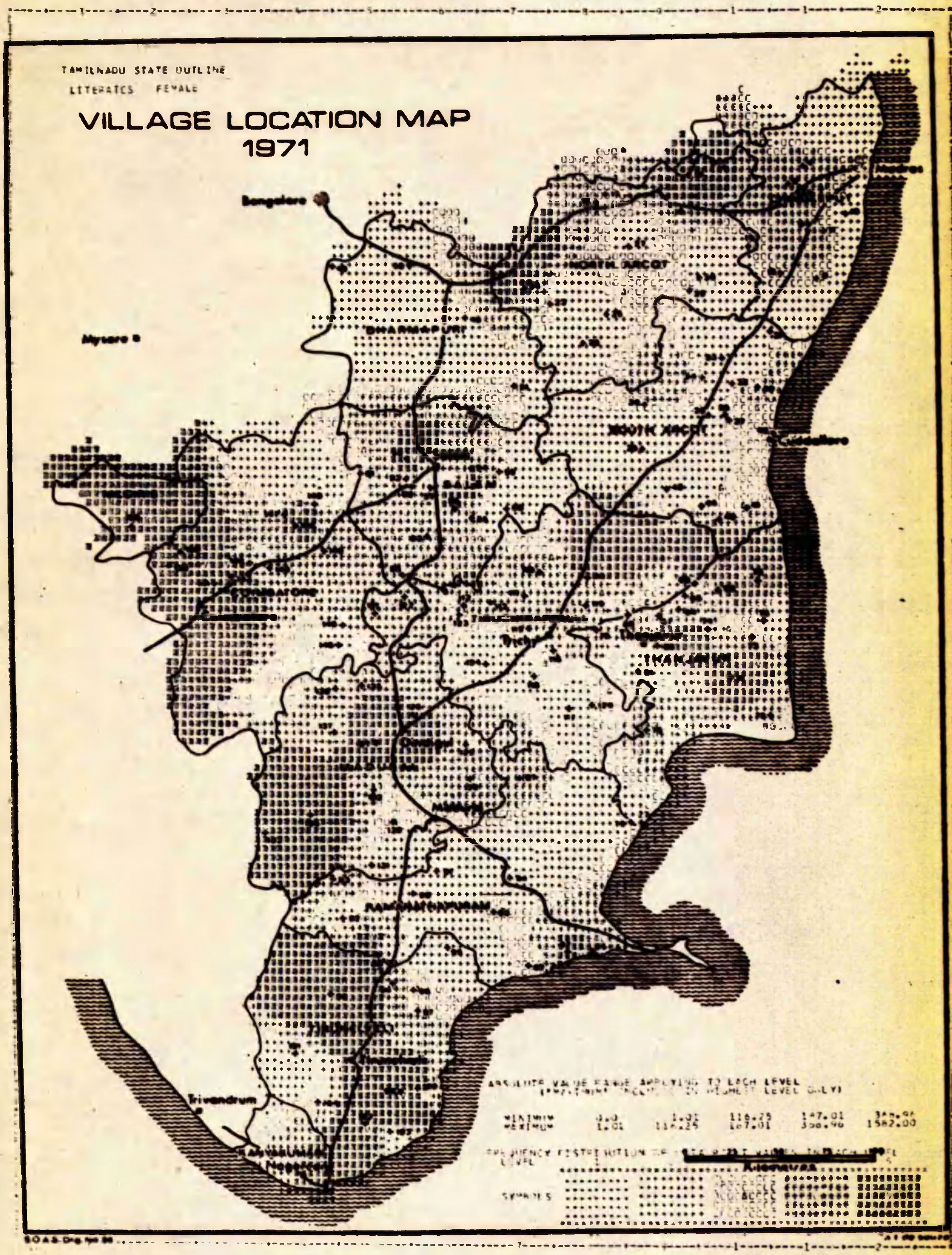
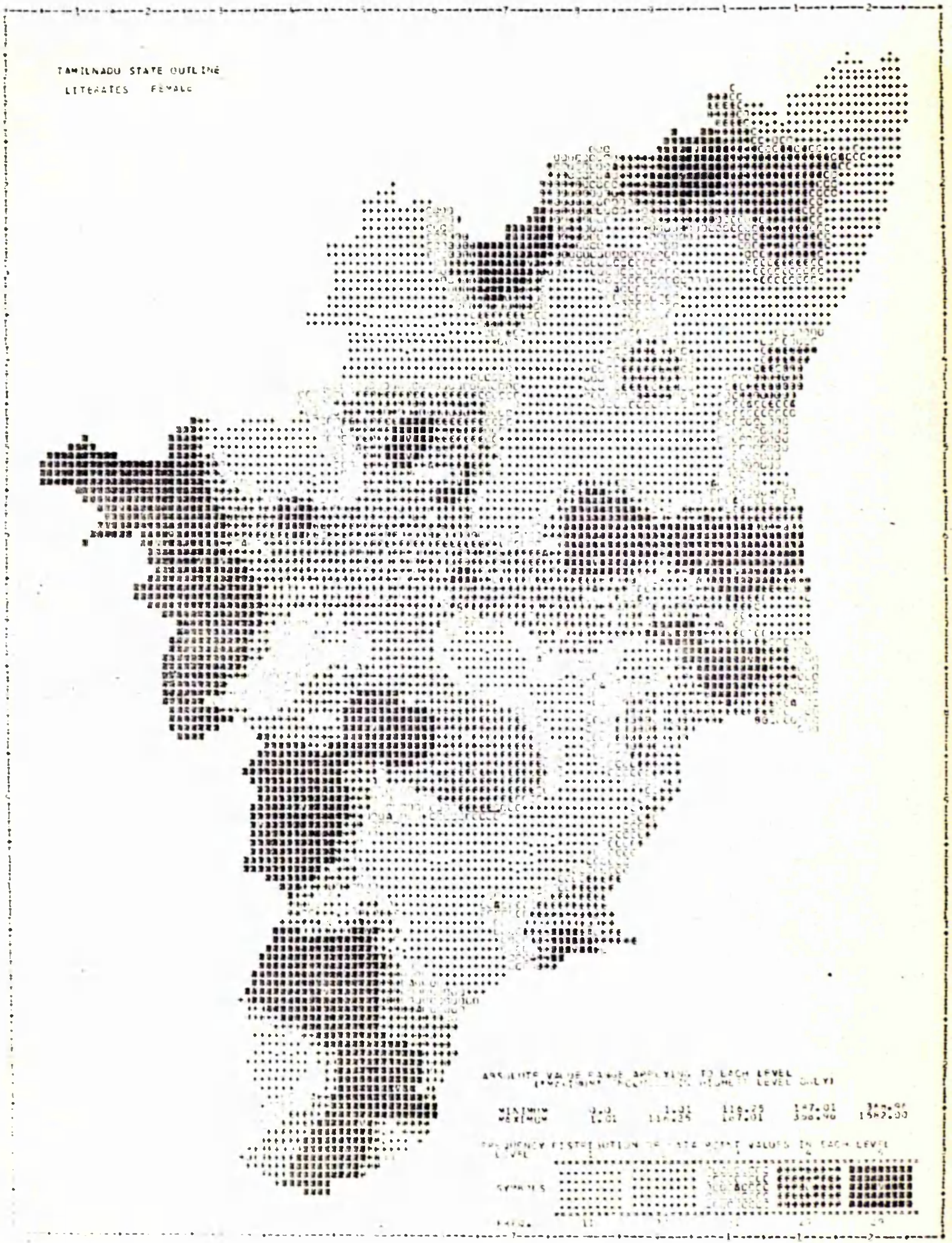


Figure 5.4 Literates - female



for literacy at the district level. The range for urban literacy rates is only 2.5%, being between 53% and 55.5%. For the rural population in contrast the range is from 28.6% to 37.5%. These figures further serve to bring out the higher rates of literacy in urban areas than in rural areas. It is noticeable that although there is some difference in the ranking of districts according to their rural and urban literacy rates, their relative positions are fairly stable (Spearman's Rank Correlation of +0.6 , significant at the 95% level). Two districts change their relative position considerably however. The Nilgiris rank second in rural literacy and tenth in urban literacy while Tiruchirappalli moves from third position on the urban literacy scale to eighth on the rural literacy scale. For Tiruchirappalli the change reflects the sharp contrast in urban and rural literacy within the district (59.9% in urban areas against 31.1% in rural areas), while in the Nilgiris the change in rank merely reflects the higher level of literacy in the urban areas of the other districts. Thus 41.3% of its rural population is literate while 52.3% of its urban population is so classified.

As indicated above there would appear to be little correlation between patterns of development at the district level and the proportion of literates in the population. Although some of the districts that are economically poor and agriculturally backward are also amongst the least literate, other poor districts such as Kanyakumari have relatively high levels of literacy. This lack of clear relationship may simply be a reflection of the coarseness of the district level analysis, and the role of literacy is the subject of further analysis at the village level.

5.2.d Caste: One of Independent India's first acts was to legislate against discrimination on the grounds of caste. The rigidities of the system, its deep roots in village life and its almost universally accepted place in social structure of the community have made it almost impossible to eliminate. In Tamil Nadu as elsewhere in India the caste system is far-reaching in its social implications and highly complex in its operation. The complexity of the system is evident in the different caste classifications found in different parts of the country. On the one hand there are the four major divions or varnas; on the other the seemingly myriad local groupings. Out of this complexity, well summarised by Basham (1962) the major features of relevance to Tamil Nadu may be distinguished.

In its desire to abolish caste and to remove the social disabilities which were inherent in the system for the lowest caste groups the Central Government recognised certain castes as meriting special status to enable their rapid rehabilitation and re-incorporation into Indian society. The poorest of these, named by Gandhi harijans or children of God, were accorded the status of scheduled casetes along with a number of other named caste groups. The purpose of listing scheduled castes was to make available economic and social opportunities on a priority basis to people from these groups so that they could " catch up " with the rest of society. Envisaged as a temporary arrangement, the system has been instituted in all States of the Union. Data relating to scheduled castes are collected by the Census, along with data related to scheduled tribes. In itself the listing of the scheduled castes provides evidence of the complexity of the caste system. In Tamil Nadu alone seventy-nine scheduled castes were listed by

Census of India. Reclassification has led to periodic adjustments in this number, the advantages accruing to those who have scheduled status making competition for recognition keen. Although it is a very crude measure the concentration of scheduled caste populations is one indication of an important feature of the social structure of the population.

In 1971 over seven million people were classified as belonging to a scheduled caste, or over 17% of the total population. Rural areas generally had approximately twice the concentration of urban areas. The proportion of scheduled castes in urban areas shows little variation (mean of 9.73, standard deviation of 3.6) while that in rural areas is somewhat greater (mean of 18.8, standard deviation of 7.3). The distribution of scheduled castes illustrates this relatively wide degree of variation and is shown in Figure 5. . Among the rural population the range of the proportion belonging to scheduled castes is from 32.3% in Chingleput to only 4.0% in Kanyakumari, while for the urban population it is from 18.6% in the Nilgiris to 3.3% in Kanyakumari.

Although the district is too coarse a unit at which to attempt to analyse the impact of caste on regional patterns of development there is one generalisation which holds true and which may be expected to be relevant to the analysis of village level patterns of change analysed in Chapters Seven and Eight. This is that the scheduled castes make up the bulk of the landless labourers in villages. In Thorner's words, these constitute " one of the most disadvantaged groups in Indian society " (Thorner 1962). As such the presence or absence of a high proportion of scheduled castes in a village may be expected to have a significant bearing on the levels of living, and this view is examined more closely in the subsequent analysis.

5.3 The Administrative sub-system

The Government's efforts to achieve development in the agricultural sector have been made through the capital sub-system. These changes have themsleves been brought about through the administrative sub-system. Thus both the inherited administrative structures and the mew administrative structures introduced since Independence are of crucial importance to an understanding of the regional processes of economic change.

Two aspects of the administrative sub-system are discussed below. First, changes in the land ownership and tenancy practices in Tamil Nadu have been brought about directly through legislation. Through these legislative reforms the Government has hoped to achieve the twin aims of bringing about social justice in the countryside and of inducing economic growth. It is important therefore to assess the degree of success which such legislative reforms have achieved. Secondly, the Central Government attempted to alter in a radical way the political and economic life of village communities through the Community Development Programme. The impact of these programmes on district level regional development is analysed below.

5.3.a Legislative reform: In 1947 there were two main forms of land ownership practised in Tamil Nadu. In Ramanathapuram, Chingleput and Tirunelveli districts there were extensive areas owned by *zamindars*. These were commonly let out to tenant farmers. Elsewhere the Madras Government of the nineteenth century had introduced the experimental *ryotwari* system in which the land was owned by the Government and let directly to the tenants. Although as Frykenberg (196) has shown the ryotwari system was complex in practice and in some cases did not differ very greatly from the _zamindari_ system it was not subject to the extreme forms of exploitation which made the _zamindari_ system so obnoxious to the Government of newly Independent India. Thus in Tamil Nadu as in many other parts of India almost the first land reform measure passed by the State Government was the Zamindari Abolition Act (1948).[1]

The seeming uniformity of the Ryotwari system that was universally in force by 1950 concealed a considerable diversity of practice in terms of cultivating systems. There were four main categories of farmer; cultivating landowners; cultivating landowners who also leased land and were therefore also tenants; tenant farmers who owned no land; and landless labourers. Although in principle the fourfold division is clear, it is very complex in operation and extremely difficult to measure in statistical terms. Estimates of tenancy vary widely. Sonachalam (1970) for example quotes two alternative figures. Using the 20% sample of the 1961 Census he calculates the number of tenant households at 735,670, giving " an average number of tenant households per village of 53 ". As is shown below this average figure is completely meaningless. He also quotes the findings of a "quick survey made by the village _karnams_" made in 1961 to the effect that " there were 313,673 tenants cultivating an aggregate area of 855,211 acres " (p.42. The precision of the statistic is noteworthy!). The contradictory nature of these estimates is highlighted by Badrinath in his penetrating analysis of land reform measures

1. The full title of the Act was _The Madras Estates - Abolition and Conversion into Ryotwari - Act_ .

in Tamil Nadu (1971) He quotes four different estimates of tenancy in the one district of Thanjavur, ranging from a low of 70,791 tenants to a high of 140,900. For Tamil Nadu as a whole the Board of Revenue quoted a figure for tenancy in 1969 of 348,416, while the Land Records Department estimate for the three districts of Thanjavur, Tiruchirappalli and Madurai alone was over 235,000. From these illustrations it is clear that an accurate estimate of the extent of tenancy is almost impossible to arrive at.

For the same reason it is impossible to estimate with any precision the extent and character of land-ownership. Sonachalam analyses the distribution of pattas as recorded in the revenue accounts.[1] Statistics are collected both for single pattas and for joint pattas. Zamindari abolition led to the increase in area cultivated by pattadars of over 4 million acreas (over 1.5 million hectares) from 13.23 million acres (5 million hectares) to 17.27 million acres (over 7 million hectares) according to the statistics published by the Revenue Office. This increase has been matched by a large increase in the number of pattas in Ramanathapuram, Tirunelveli and Chingleput. Between 1954-55 and 1964-65 there was also a growth in the number of pattas in the State as a whole. The number of single pattas rose from 2.275 million to 3.456 million, while the number of joint pattas rose from 8.978 million to 10.547 million. These increases might be taken to mean that increased dispersion of land ownership had taken place. This was not necessarily so, however, for any individual

1. A patta is an individually or collectively owned parcel of land; the owner is known as a pattadar.

can own more than one patta, and thus these statistics cannot be used to make inferences as to the nature of land ownership per se.

Even the number of landless labourers is imprecisely known. The 1951 Census placed in this category all " employees of cultivators ", a catch-all definition which included non-agricultural as well as agricultural workers. In the 1961 Census the definition was changed to that of " one who works on another's land for wages in cash or in kind". Unfortunately the situation is complicated by the fact that an unknown number of owners also act as labourers at some times of year. These difficulties are highlighted by the available statistics. A conversion factor applied to the 1951 Census figure yields a total of 1.9 million agricultural labourers. However, the first Agricultural Labour Enquiry (1950-51) estimated the number of landless labourers at 2.2 million, with a further 3.2 million classified as " landholding workers ". The second Agricultural Labour Enquiry (1956-57) put these two figures at 2.4 million and 1.4 million respectively, while the 1961 Census put the total number of agricultural workers in the State at 2.8 million. By 1971 the Census figures suggested yet another dramatic change, the total number of agricultural labourers being put at 4.5 million. The only clear point to emerge with any certainty from the welter of apparently conflicting data is that a sizable proportion of Tamil Nadu's rural population is without title to any land.

Given this "structural inheritance " , the Government of Tamil Nadu embarked on an ambitious programme of land reform measures whose implications might have been expected to be far-reaching. Thus their nature and degree of implementation deserve careful examination. The legislation passed by the State Government between 1947 and 1971 can be classified under the headings of protection for tenants, fair rents legislation, and the imposition of ceilings on size of holdings. Through the various measures that have been passed it has also been intended to assist landless labourers and to increase productivity by reducing fragmentation.

The main substantive measures of land reform after the abolition of the zamindars were :

1. The Madras Cultivating Tenants Protection Act 1955
2. The Madras Cultivating Tenants (Payment of Fair Rents) Act 1956
3. Madras Public Trust Act (Regulation of Administration of Agricultural Lands) Act 1961
4. The Madras Land Reforms (Fixation of Ceilings on Land) Act 1961
5. The Tamil Nadu Agricultural Lands (Record of Tenancy Rights) Act 1969.

It is not the purpose here to go through all these Acts in detail, but it is necessary to outline their main provisions and achievements.

The 1955 Act was intended to protect tenants from eviction and from the "unjust" resumptiom of lands for private cultivation, although it specified that any owner wishing to resume land for his own cultivation could do so. It was made retrospective to December 1953, in an attempt to overcome the tactics to which many landlords were known to have resorted of evicting tenants as soon as the threat of legislatiion became known. In twelve years of operation just under 19,000 suits were filed. Even taking the lowest estimate of the number of tenants in the State this still represents less than 5% of tenants taking any action to court. While it could be inferred from this that all was well in the agricultural sector, it seems more probable that the oral and informal nature of the tenancy agreements made recourse to the courts impracticable for all but the securest or most aggrieved of the tenants.

The 1956 Fair Rent Act fixed rents at 40% of gross produce, to be paid in cash or in kind. This represented the rent for wet land, and lower rents were to be payable for poorer quality land. Again, the number of cases taken to court (3,673 by June 30th 1967) was tiny. Although either the tenants or the landlords could take cases to court it is not surprising that only the tenants had taken such action. Sonachalam concludes from this evidence that " on the whole it seems that the tenants in Tamil Nadu are satisfied with the rates of rents fixed and other ancillary conditions ". Evidence from the field would suggest that such a conclusion is premature (Ladejinsky 1963, Badrinath 1971).

In 1961 the Government of Tamil Nadu introduced its first land ceilings legislation, in which no one family was to be allowed more than 30 standard acres[1]. Exceptions were made to this law, and fourteen different categories of land were exempted, but the Government expected it to apply very widely. In 1951 the Land Revenue Reforms Committee had estimated that if all holdings in excess of 5 wet acres were to be declared surplus a total of 2.55 million acres would become available for distribution. Subsequent estimates were less optimistic. In 1962 the area estimated by the Government as being available was 251,180 acres ,

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1. The definition of the standard acre is given in Footnote 1 on Page 43 , Chapter Two.

which on further analysis was reduced to 82,000 acres (33,000 hectares) - less than one third of the amount estimated originally immediately after the legislation was introduced (Badrinath 1971). By September 1970 only 26,542 acres (just over 10,000 hectares) had been notified as being surplus, that is just over 10% of the area originally estimated in 1962 as being likely to be made available for distribution. Of this only 15,000 acres (6,000 hectares) had actually been assigned. Nine thousand six hundred landless labourers had benefitted, of whom nearly half were in the one district of Thanjavur. To put them in perspective these figures should be set beside the figures for total cultivated area and the rate of population increase in the State. Thus the area affected by the land ceilings legislation was less than 0.1% of the total cultivated area of the State. It can also be argued that less than 1% of the increment to the landless labour population (which can be estimated at approximately 1.5 million between 1961 and 1971) benefitted in any direct way from the legislation.

The last remaining piece of legislation carried out before 1971 was the tenancy registration Act, whose chief aim was to formalise relationships between tenants and landlords. By 1971 it appeared that this Act had also failed to achieve its goal. Badrinath, the Government officer in charge of its implementation , conducted a special survey in Madurai, Thanjavur and Tiruchirappalli. In these three districts there are over 4300 villages. Of these, one third gave no intimation of tenancy at all. The total area intimated under the Act was 86,357 acres (35,000 hectares), less than 2.7% of the total cultivated area. Yet all the independent evidence suggests that these three districts are characterised by very high rates of tenancy.

Both in intention and in design the legislation of the last twenty-five years has been radical, and has attempted to transform the patterns of relationship which characterised Tamil Nadu's agricultural sector until Independence. All the evidence suggests that results up to 1971 had fallen far short of expectations, in some cases by a considerable distance. To say this is not to underestimate the changes which have occurred, but to point to the necessity for a critical eye in reviewing the nature of the legislation as implemented. Three points of particular relevance to the subject of this thesis stand out.

1. As has been shown a major part of land reform legislation has been concerned with tenancy reform. While the proportion of the labour force in this category is still debateable it is most unlikely that it stands at more than 20% for the State as a whole. This 20% is highly concentrated in the Districts of Thanjavur, Tiruchirappalli and Madurai. Two of the Acts passed had specific reference to only two of the Districts - the Protection of Pannaiyal's Act 1952 and the Kaieruveram and Mattuvaram Act of 1958, which applied only to Thanjavur and Tiruchirappalli. Outside these areas the impact of the tenancy legislation is inevitably negligible.

2. Land ceilings legislation had affected a minute proportion of the agricultural area by 1971. The land which had been redistributed was often marginal land, requiring considerable capital to develop it. Most of the Districts were completely unaffected, Thanjavur having nearly half the declared surplus area. These findings of Badrinath and Sonachalam were further supported in the survey of 132 villages carried out for the present study. In only three of the villages studies was it reported that the lowering of the ceiling to 15 standard acres, a measure announced in the budget

speech of the Tamil Nadu Finance Minister in 1970 , would have any effect at all on their own village. These facts suggest that the regional impact of land ceilings legislation on regional patterns of agricultural change. has been minimal.

3. Regional patterns of economic change have been only marginally affected by the reforms made within the administrative sub-system, apart from the initial change of the abolition of the zamindari system. This, and some of the subsequent legislation , removed the largest landowners. However, even now very large landholdings still exist, sometimes nominally divided between members of a family, sometimes under exempt crops such as sugar cane or orchard groves. In one Block in Ramanathapuram District I was taken by the Block Development Officer to see the " most progressive farmer in the District "- who had over 250 hectares of dry land in one farm! This example illustrates one of the most important difficulties facing the legislators, that of reconciling the aims of social justice with those of obtaining a rapid increase in productivity, for it has yet to be demonstrated that the break up of farms such as this automatically leads to increased efficiency or higher output.

The lack of effective implementation of the legislative reforms makes any assessment of their impact on regional patterns of development superfluous. However, it is clear that those who have been in a position to benefit from the reforms themselves have been in the worst position to take advantage of that opportunity. One further example makes the force of this last point abundantly clear. In addition to the various measures of agricultural reform outlined above the Government of Tamil Nadu initiated a scheme in 1965 (under Government Ordinance No.5346) to settle 10,000 families on 50,000 acres (20,000 hectares) of Government land. As early as 1961 the Government had appointed officers to determine the extent of such land and its localisation to determine whether it could be used for this purpose should it be required. The Board of Revenue estimated in 1963 that over 197,000 acres (80,000 hectares) would be available. As with the land ceilings surplus estimate, this was rapidly whittled down to 25,000 acres (10,000 hectares) . By 1970 just over 13,000 acres (5,000 hectares) had been allotted to little over 3,000 families. Less than 8,000 acres (3,000 hectares) had been brought under cultivation. Not only had very few families been settled but the costs had been extremely high. By 1971 Rs 10 million had been spent. Badrinath's survey revealed that in order to begin to make cultivation profitable a cultivator or tenant would require at least ten acres (four hectares) of irrigated land. In his survey of 65 villages in Thanjavur he found that 65% of tenants leased between 1 and 5 acres (less than two hectares) and that fewer than 12% leased more than 5 acres (two hectares) In the newly developed areas on Government land the need for larger units is even greater in view of the marginal nature of much of the land, and thus the three acres which each settler on the Government land farms is not the kind of base from which a dramatic attack can be launched on the problem of low productivity in Tamil Nadu's agriculture.

5.3.b Community Development: The second element of the administrative sub-system is that of community development, with its related political and economic goals. The motivation behind the Community Development programme was a mixture of social economic and political aims. The encouragement of democratic governemnt at a local level; the dissemination of innovations in agriculture, new industrial techniques, education and health care; and the integration of village India with the goals of social and economic progress. It is through its Community Development programme that Government action may be expected to have impinged most directly on patterns of regional development within the State. Unlike the legislative land reforms the Block Development Programme now touches every district, every taluk and every village, however slight the degree of contact. Thus every village is within reach of the Government's chief agents of change - the extension officers and village level workers. Equally every village has some democratic representation on the Panchayat Union council. Thus the impact of these political innovations must be assessed with reference to their bearing on development within the State.

In order to bring about the changes which were thought necessary a new administrative structure was sought which would be development orientated. At the national level this was inaugurated in 1952 with the founding of the National Extension Service and Community Development Administration. As Dubashi (1966) puts it " community development was conceived as a method and National Extension Service as the agency through which it was intended to create a new pattern of society in the countryside" (p.14). In particular the role of the Collector was to change from that of a benevolent representative of a foreign power to that of the co-worker for development alongside the democratically elected representatives of the people. In practice it was left to the States to work out their own pattern through which these aims could be achieved, and wide divergences in practice resulted.

The achievement of the political aims was looked for through the re-invigoration of the system of local government known in North India as Panchayati Raj (the rule of the five). In its early stages of implementation the democratic strand was weak, and following a recommendation from the Mysore Committee a district level executive body (known in some States as the "zilla parishad") was establishd by some State Governments. In Tamil Nadu this took the form of setting up Panchayat Unions - groupings of individual Panchayats to a size corresponding to that of a Block. The Blocks themselves were originally conceived as the heart of the Community Development Scheme, its pump-house through which ideas and hardware flowed in two directions; from the State Government down to the people and from the villages back to the administration. Also in its original conception the Block was to comprise 100 villages and about 66,000 people. Heading the organisation at Block level was to be the Block Development Officer, under whom would be seven or eight extension officers. Such an ambitious programme involved an enormous training scheme, but by the early 1960's virtually the whole of India was incorporated into the new system. Most of the necessary financial resources came from the Central Government, which consequently had considerable influence over the training programmes and the initial implementation, even though in theory the State Governments were to exercise largely autonomous control. This autonomy had begun to find expression by the early 1960's, as the tensions between the different levels of local and State administration began to make themselves felt.

In Tamil Nadu the political expression of the Panchayati Raj ideal was developed through the formation of Panchayat Union Councils. These were composed of representatives elected from every Panchayat and township council. Thus it was entirely an indirectly elected body, comprising some 40 to 60 members. It met at least once every three months under the chairmanship of the Development Commissioner.

How far has the growth of these new institutions affected the structural patterns of economic development? And how far have they channelled the new political forces towards directed economic expansion? As Dubashi (1966) has pointed out the development of Panchayati Raj institutions alongside those of the pre-existing bureaucratic institutions has meant the operation of a "mixed" system of administration and local government. In Tamil Nadu there was clear evidence that many of the teething problems remained in 1971, and that the implementation on the one hand of the Block Development Programme and on the other of its political counterpart the Panchayat Unions was variable from place to place. In many areas the Block Development authorities were acting as agents both of education for agricultural change and as the channels for new seeds, fertilisers and other inputs. On the other hand many officers reported on the difficulty of reaching a wide region, and several of the aspects of extension work were showing little sign of dynamism.

There are good reasons for these difficulties quite apart from the problems caused simply by working within a new political framework. Difficulty of communication is probably the most significant. Every Block was provided with an official jeep for the use of the Block Development Officer and his staff. In practice this was completely inadequate to cover an area which often included 100 villages. Thus many of the remoter villages have very little contact with the Block Development Office. In theory of course the link between the Block headquarters and the villages is the village-level worker, but in practice the effectiveness of such a link is highly variable.

These comments are made by way of introduction to the Government of Tamil Nadu's own assessment of the programme. It is extremely difficult to form an independent judgment on the achievements of the projects, not least because of the range of yardsticks by which that success could be measured. The fundamental point of interest in this study is the extent to which economic activity in the villages has been affected directly as a result of the activities of the Blocks' activities. There are no data available from which an assessment of the regional impact of the Block Development projects may be analysed, but some conclusions are possible on the basis of the aggregated reports published in Tamil Nadu: an Economic Appraisal 1971.

By the end of the 1960's 375 development blocks had been established in Tamil Nadu. Of these 199 were in their first five years of existence (termed Stage Two) and 175 were in post-Stage Two. Thus the scheme was already well established and had been operational in many parts of the State for over five years. The achievements of the programme can be summarised under the headings through which the activities are carried out. In agriculture the blocks served as distribution points for new seed (13,600 tonnes of improved paddy and 1,600 tonnes of improved millets in 1969); for chemical fertiliser (80,000 tonnes of ammonium sulphate and over 260,000 tonnes of other chemical fertilisers); of improved farm implements (31,000); and of pesticide

(19,000 tonnes). In gross terms some of these are impressive figures. In particular the blocks were important distribution centres for fertiliser. When broken down to the individual block level however the amounts are small. Thus the average distribution of all chemical fertilisers in 1969 was just over 90 tonnes per block.

Activities in other fields also continued. Particular efforts were made in animal husbandry, and the programme of castration of scrub bulls (over 86,000 in 1969), of innoculation of cattle (2 million) and of artificial insemination (more than 69,000) was vigorously pursued. Through the health and sanitation programmes nearly 350 Primary Health Centres were opened by the end of March 1970, and improvements to village drinking water supplies, drainage and local roads were also undertaken. Similarly the family planning programme was being operated through the Block Development Organisation. Over 75,000 sterilisations had been carried out on men and nearly 8,000 on women.

By 1971 the Block Development programme was beginning to take effect in Tamil Nadu. In many areas the direct effects were still very thinly spread, but it seems that the programme could have begun to influence development. Contrasts in the effectiveness of different Blocks may be reflected to a certain degree in regional rates of change, although its contribution can only be slight .

5.4 Conclusion

It is clear from the evidence of these three Chapters that the physical, capital, labour and administrative sub-systems all have a bearing on the regional patterns of development within Tamil Nadu. In terms of the relatively large-scale area of the district it has been shown very clearly that the context of economic change varies significantly from one part of the State to another. Some of the districts are clearly disadvantaged in terms of several of the criteria discussed above. Dharmapuri and Salem Districts in the north-west, and Ramanathapuram in the south-east contain some of the least favourable environments for agricultural development, at the same time having received few of the benefits of legislative and administrative change designed to bring benefits to those dependent on agriculture. In contrast the districts of Thanjavur, Coimbatore, Chingleput and North Arcot have considerable advantages both in terms of their physical environment and in terms of their developed resources.

While it may be expected that villages will share in some of the general characteristics of the districts in which they are set, it is also apparent that even within districts there are very significant contrasts . Thus in Ramanathapuram for example there are very pronounced contrasts between the well-watered, fertile areas of the west, bordering the foothills of the Western Ghats, and the arid sandy landscapes of the east. Even within the eastern part of the district the villages on the coast itself differ in many important respects from those slightly inland. Thus while the broad regional contrasts in the relevant systems are important, it may be hypothesised that village level patterns of change may show not only general regional patterns but systematic patterns of change which may reflect systematic non-regional factors as well as the general regional characteristics. Of these systematic factors urban accessibility is the most important, and the remainder of the analysis focuses on the measurement and analysis of accessibility as a factor in village level agricultural change and development.

CHAPTER SIX

The Structure of the Transport Network

6.1. Introduction

In the previous Chapters the components of the agricultural systems in Tamil Nadu have been examined with a view to analysing their contribution to regional patterns of agricultural change. The picture has been built up of a complex series of interactions between diverse variables which together have produced considerable regional contrasts in the nature of agricultural activity practised in Tamil Nadu. It has proved possible to identify the important role played by the physical environment in shaping the agricultural systems and in influencing patterns of economic activity. Until this point however the discussion has remained largely at a general level and has made heavy use of secondary material. Although such analysis has enabled some of the factors affecting regional development to be assessed many specific questions remain unanswered. In particular no attention has been paid to the possibility that among the regional factors there may also be systematic influences at work which play a strong part in producing the spatial patterns of change. The remainder of this thesis examines the role of one group of factors which it may be argued are of considerable significance to the whole theme of regional development patterns ; accessibility.

The key role played by accessibility in the development process has long been argued by Governments and academics alike. The Tamil Nadu Economic Survey for 1971 , for example, states that " roads play a pivotal role, not only in aiding economic and social development, but also in creating new links between towns and villages, thereby bringing villages into the mainstream of economic life " (p.93) Such emphasis on the importance of transport has been made by several writers (e.g Owen 1967, Kansky 1963, Taaffe and Gauthier 1973).

Despite the acknowledged importance of accessibility to the process of economic and social development, definition of the concept of accessibility is still far from agreed or precise. Generalised measures of accessibility of one sort or another have long been used to try and express the degree of development of a transport system within a region. Accessibility may be defined for example in terms of the density of the transport network of roads and railways expressed per unit of area or of population. Gross measures such as these have long been staple fare for those trying to contrast the transport systems in different regions (Spate and Learmonth 1968). Such indices give a general impression of the availability of roads and railways and are basic to any further analysis of regional accessibility, but they give no impression of the structure of the system and of the regional variations in it.

It is clear that gross indices such as these are only very general approximations to the nature of accessibility, and much refinement of the concept is needed before hypotheses attempting to relate accessibility to development or innovation can be tested. The development of topological indices of the structure of transport networks (Shimbel 1953, Kansky 1963, Taaffe and Gauthier 1973, Hay 1973) has gone some way towards overcoming this problem and towards isolating the components of accessibility within the system.

In this Chapter the general character of Tamil Nadu's transport system will be examined. After a brief discussion of the nature and form of the State's road and rail development, an analysis will be made of the structure of the transport network at the State and District levels. This provides the basis on which the subsequent analysis of village level patterns of economic change and of agricultural development is carried out.

6.2 Gross Characteristics of the Transport System

Tamil Nadu is one of India's best served States in terms of both road and rail transport. The transport system has expanded very rapidly since 1947, although the basis of the expansion of road transport was laid in the Nagpur Plan of 1943, in which plans were made for the development of an efficient arterial road system to cover the whole of India. After Independence the Central Government remained in charge of the programme of national highway building but all other roads were left to the State Governments. By the end of the Second Five Year Plan the objectives of the Nagpur Plan had virtually been achieved, and the Third Five Year Plan introduced a twenty year programme.

As a result of the efforts made during the planning period Tamil Nadu had over 22,500 kilometres of macadamed road or concrete surface and 24,500 kilometres of unsurfaced road. The network had been further improved by the construction of 118 major bridges. Thus between 1961 and 1971 alone the length of surfaced road per 100 sq. kilometres rose from 25 kilometres to 38 kilometres. Expressed in per capita terms it rose from 98 kilometres per 100,000 people to 127 kilometres per 100,000 people. While this is not a high figure compared with that found in the industrial regions of western Europe, it is much higher than for most other Indian States. Thus Maharashtra for example, one of the most developed States in India, had only 10 kilometres of surfaced road per 100 sq. kilometres, and Gujarat, another relatively industrialised State, had only 8 kilometres of surfaced road for every 100 square kilometres.

Although improvements to the road system have been impressive, the railways have received priority treatment in terms of investment (Owen 1967). The Southern Railway had a route network of 7,500 kilometres, over half of which was in Tamil Nadu. However, it is not a uniform system as there are some 870 kilometres of broad gauge line and nearly 3,000 kilometres of metre gauge. The broad gauge links Madras with the west and south-west while the metre gauge links it with the south. The lack of a unitary system imposes constraints on the degree to which the State is interconnected by rail, but when both gauges are taken into consideration Tamil Nadu has greater accessibility to a railway service than almost any other State in India.

6.3 The Structure of the Transport Network

Accessibility refers to the ease or difficulty of movement or communication - but from where and to where? Clearly the averaged figures of road and rail density give little indication of the accessibility of individual places either to each other or to the system as a whole. Three aspects of accessibility are the focus of interest in the subsequent analysis. The overriding question is that of the effect of village accessibility on village level patterns of agricultural change. Village accessibility is defined in terms of distance to markets, neighbouring towns, cities, roads and railway stations, as well as in terms of the accessibility of the village to the wider transport system. Secondly, the accessibility of towns which make up the nodal points of the transport system is analysed. The link between a village and its local town may be seen as simply the lowest link in the chain which connects it to the wider region as a whole, and thus the extent to which that town itself is accessible to neighbouring towns becomes important. Finally there is the accessibility structure of the system as a whole, in which not only the nodal properties of accessibility are regarded as being of importance but also the structural properties of the network.

Even in its most basic and simplest form accessibility can be measured in a variety of different ways. Straight line or shortest route distance, cost or time measures can be used and the resulting measures be converted into isoline maps indicating accessibility surfaces (Haggett 1965). While such measures are appropriate for the study of the accessibility of individual locations, the regional development of an area may also reflect the wider aspects of general accessibility. In this Chapter the focus will be on the structure of the transport network within Tamil Nadu and of the transport network within the districts. An attempt will be made to analyse the properties of these networks in order to assess the regional structure of accessibility. The development of graph theory has provided a tool with which some important elements of the structure of networks can be analysed (Chorley and Haggett 1969), and use is made below of some graph theoretic and topological measures in order to describe and compare networks within Tamil Nadu.

As long ago as 1961 Garrison and Marble suggested that there might be a measurable relationship between the structure of transport networks and levels of economic development. They looked at the relationship between the environment (physical, social and economic) and a number of graph theoretic indices of network structure. Treating the indices of accessibility as the dependent variable they examined the strength of the relationship between Berry's (1958) indices of development, indices of size shape and relief, and eight indices of network structure. Their findings confirmed the hypothesis that at the national level there was a significant correlation between network structure as measured on the topological and graph theoretic indices and economic developments.

Kansky (1963) refined some of the topological indices by which network structure can be defined. He also found a significant relationship between levels of economic development in twenty-five countries and their network structures, but in his work he treated the degree of development as the dependent variable and the character of the network structure as the independent variable. This contrast points to the chicken and egg nature of the relationship between transport networks and economic development. What both studies strongly suggest however is that it is possible to measure networks in such a way as to be relevant to the question of national patterns of economic development. In order to obtain a clear understanding of the sequence of changes, however, it would be necessary to trace the development of the transport network through time and to relate the changes in the economic structure to the changes in the patterns of network accessibility. Such a procedure would be particularly important for the kind of macro-level generalisations made by Garrison and Marble or by Kansky.

Such a "time-slice" approach is less relevant to the present study because the elements of change which are analysed are all very recent innovations. They all post-date the network changes which have given rise to the present network structure. Thus the lack of any analysis of the changing structure of the network in Tamil Nadu is not critical for in terms of the subsequent analysis the network may reasonably be regarded as the independent variable .

6.4. The Indices of Topological Structure

6.4.a Definitions: Topological and graph theoretic indices are arrived at by simplifying the networks to their basic components, that is the number of points in the network and the lines connecting those points. Although differing terminolgy has been used to describe these elements, points or nodes are now commonly referred to as vertices, and routes or lines as edges (Chorley and Haggett 1969, Taaffe and Gauthier 1973, Hay 1973). Two basic types of measurement are possible;

1. the measurement of the structural properties of the network as a whole and its summary in one index figure;
2. a vector of numbers which measures the relationships between the individual elements and the network.

In the subsequent sections three questions are examined.

1. To what extent is it possible to define the structure of Tamil Nadu's transport system by means of topological indices?
2. How far may the structure of transport networks be related to regional contrasts in development within the State?

3. How far may the structure of the networks within the districts be measured and then compared?

A range of topological indices is available for the description of transport networks. Kansky (1963) has shown some of these indices to be less stable than others and therefore less reliable measures of the significant elements of network structure. In defining the network two sets of criteria are of prime importance, those by which the vertices and the edges are defined. As most topological measures are calculated from the relation between the edges and vertices it is clearly essential that their definition should be stable from one region to another.

i. Vertices: In the strict sense a vertex is formed by any junction of edges on the network (Chorley and Haggett 1969). However, in the study of transport networks urban centres are commonly the foci of the transport system and hence urban centres are regarded as the vertices in the topological analysis (Taaffe and Gauthier 1973). Even so the scale at which the analysis is to be carried out has a bearing on the size of urban centres which can both logically and practically be treated as vertices. It can be argued that networks may be viewed as themselves having a hierarchical organisation just as urban centres can be grouped hierarchically according to size and function. Theoretically it would be possible to treat every urban centre however small as a vertex in the transport network. Logically and practically such a procedure would have little to recommend it. Logically, because it is clear that the largest towns have both far greater interaction and influence within the system than the smallest ones, and the treatment of vertices as having identical significance within the system introduces considerable interpretation problems. Practically, because the computation of linkage matrices for all towns with a population of 5000 or more in Tamil Nadu would be prohibitive. Thus on both counts such a definition is ruled out.

In the subsequent analysis two definitions of vertices are adopted. The general pattern of connectivity of the State as a whole is carried out using the towns of 50,000 and above as the vertices. This definition yields a total of 36 vertices or approximately three per district. This level of analysis shows what may be termed a primary level of accessibility, showing as it does accessibility of the major district centres within the State. Within the districts the degree of connectivity of much smaller towns becomes relevant. Although the Census of India classifies all places with a population of 5000 and above as urban, Mitra (1965) has shown that a significant proportion of the towns within the 5000 to 10000 range fail to qualify as urban on at least one of the four criteria suggested by the Census as being necessary for classification as urban. For this reason the size limit of 10,000 has been chosen as the basic qualification for district level vertices.

Inevitably there is an element of arbitrariness in the selection of the size limit 50,000 or 10,000. The reason for the former choice lies in the fact that towns with a population of less than 50,000 are rarely found to possess the attributes of a dynamic modern sector economy that might be expected to go with the predicted urban role of stimulating social and economic change within the region. This view is supported by a number of writers on Indian urban growth. Hoselitz (1958) for example argued that a population size of 250,000 was a pre-requisite to the existence of a sufficient range of services and an adequately developed infrastructure to allow rapid economic growth. Many of the towns in Tamil Nadu which have a population of 50,000 or less have few modern characteristics and serve a very limited range of functions. There are some exceptions. For example, there are a few industrial townships that have grown up in the last twenty years. Often little more than suburbs of the largest industrial cities of the State they are usually characterised by a large proportion of their labour force working in modern medium or large scale industries. Avadi, on the outskirts of Madras, is an example. Very occasionally townships have sprung up in response to a particular development. Neyyveli Township, which has grown up as a result of the exploitation of the extensive South Arcot lignite deposits, is the best example. Neyyveli had grown sufficiently rapidly to take its population above 50,000 in 1971 and it is thus included in the analysis. A second exception may be found in those towns which, though they have a population smaller than 50,000 may serve economic functions of considerably greater importance than their population size would suggest. In some parts of Tamil Nadu there are extensive regions that have no town of 50,000 population, particularly in Dharmapuri and Ramanathapuram Districts. It might be argued that such towns as do exist in these regions must serve and should be included on those grounds. However in these poorly urbanised areas those towns that do exist reinforce the impression of economic stagnation and decline rather than of wide regional economic involvement, which suggests that there are no special grounds for their inclusion.

On practical grounds there are good reasons for limiting the number of centres studied in the analysis. As the matrix gets larger so the computational problems increase. Although this presents no difficulty from the point of view of computer analysis, there remain the compilation problems of matrix preparation. In the absence of strong theoretical justification for lowering the size level of qualifying urban centres there is little justification for greatly increasing the complexity of the compilation procedure. However the arbitrariness of the definitions must be expected to have some effect on the nature of the results, and were different definitions adopted there would clearly be some modification to the results obtained.

ii. Edges: The definition of edges or routes also poses problems. Topological graphs fall into two categories, planar and non-planar. In a planar graph all the intersections are vertices; in a non-planar graph the edges may cross without passing through vertices (Chorley and Haggett 1969). The road map of the districts of Tamil Nadu presents problems of definition because there are intersections of edges which do not meet at vertices as defined above. In relation to the total number of edges and vertices however this number is very slight, and thus the graphs may be treated throughout as planar graphs. This treatment may lead to the overstatement of scores on such indices as the alpha and gamma indices which relate the actual number of edges to the maximum possible number of edges which can occur on a planar graph, but the exaggeration is very slight.

The edges themselves have been variously defined by different researchers. Garrison and Marble (1961) in their study of connectivity and development used railways and national highways as edges in the network. Kansky (1963) used national railway networks as the basis of his analysis. In Tamil Nadu the structure of the rail network could be held to be relevant only at the State level and for the analysis of the accessibility of larger towns and cities. Equally important at the State level is the distribution of State and National highways. The indices of connectivity and network structure for Tamil Nadu are calculated on the basis of both road and rail systems, and the edges are defined as these National and State routes.

At the district level the minor road network assumes importance. It has already been shown above that there are over 22,000 kilometres of macadamed road in the State. The total length of the shortest path network, following only those roads marked in the District Census Handbooks for 1971, is 8,620 kilometres. Thus although there is no indication on the source maps it can be assumed without great risk of error that the majority of roads defined as edges in this analysis have all-weather surfaces. Thus although district level roads are often unsuitable for any form of heavy traffic owing to the weakness of culverts and bridges (Owen 1967), they play an important part in the patterns of movement between small towns.

6.4.b The indices:

i. Alpha: Taaffe and Gauthier (1973) argue that the most important property of the network is its degree of connectivity. The connectivity of a network may be measured by two indices, termed by Kansky (1963) the alpha and gamma indices. The alpha index is calculated from the formula [1]

$$A = e - v + p / 2v - 5$$

1. This is the formula for planar graphs, and is derived from the formula for defining the maximum possible number of circuits in a planar network and comparing it with the actual number of circuits.

In this formula e = the number of edges, v = the number of vertices and p = the number of unconnected sub-graphs. Thus alpha measures the number of linkages within a network over and above those necessary to make a circuit. A circuit can be defined as a " finite closed path in which the initial node (or vertex) of the linkage sequence coincides with the terminal node " (Taaffe and Gauthier 1973 p). The higher the alpha index the greater the number of alternative routes between vertices and hence the greater the connectivity of the system. Multiplied by 100 the index is expressed as a percentage. A completely connected graph has an index of 100%, and all disconnected graphs have an index of zero. The index is therefore independent of the number of vertices, although as is shown below the size of the graph plays some part in the probability of its being completely connected.

ii. Gamma: The gamma index is a simple ratio of the number of edges in the network to the maximum possible number of edges, written as e / e_{max}. In planar graphs the maximum number of edges is increased by three for the addition of every vertex for any network with more than two vertices. Thus the gamma index is given by

$$G = e / 3(v - 2)$$

This index is also commonly expressed as a percentage, and any completely connected graph has an index of 100. As the index approaches zero different types of disconnected graphs or trees are described.

iii. Beta: A further ratio index is used by Kansky, the beta index. This is the simplest of the three, and is obtained from the formula e / v. Its logical basis is similar to that of the alpha and gamma indices, and for planar graphs its value can range from 0 to 3. An index of 1.0 signifies a minimally connected network, higher values resulting from more complex graphs.

All three indices use the same basic components - vertices and edges - and they are strongly correlated in practice. In Tamil Nadu for example there is a correlation between the alpha and beta indices for the thirteen districts of 0.93 (Spearman's Rank Correlation), and between the alpha and gamma indices of 0.94. Thus although they do not measure identical properties of the network they are closely interrelated.

On the basis of the alpha and gamma indices Taaffe and Gauthier suggest that it is possible to define three basic network configurations. These are termed the spinal, grid and delta. The spinal configuration is found in the minimally connected network, where the gamma index is always equal to $v - 1 / 3(v - 2)$, and the alpha index always equals zero. This is because in a minimally connected network there are no redundancies or circuits. The antithesis of the spinal configuration is the delta, in which the number of edges is always $2v - 3$, and therefore

$$G = 2v - 3 / 3 (v - 2).$$

In the delta configuration alpha is equal to $v - 2 / 2v - 5$. Taaffe and Gauthier show that it is possible to identify cutoffs on the gamma and alpha indices which accord to the three configurations. In the spinal configuration gamma lies between 33% and 50% while alpha is zero. In the grid configuration, which lies between the spinal and delta configurations, gamma lies between 50% and 66% and alpha lies between 0% and 50%. In the delta configuration gamma lies between 67% and 100% and alpha between 50% and 100%. Such a classification of the graphs makes comparison between them easier.

iv. Accessibility matrices: All three indices outlined above measure the overall structure of the network. They do not give any indication of the degree of accessibility of individual nodes within the system to other parts of it. Re-arrangement of the data into a matrix permits the analysis of the accessibility of individual nodes.

a. The 'T' Matrix: In its simplest form such a matrix would be in binary terms. The presence of a link between two places or nodes is indicated by the figure 1 and the absence of such a link by a zero. If the rows are then summed the total number of direct links between any one vertex and all the other vertices is obtained. This sum is defined as the " degree of the node " (Taaffe and Gauthier 1973). By ranking the degrees of the node for each vertex it is possible to establish a hierarchy of centres according to their degree of accessibility. However, as Taaffe and Gauthier point out, the degree of the node is subject to serious limitations as a measure of accessibility.

In order to assess the total accessibility of any vertex it is necessary to take into account not only the direct links between that vertex and its neighbours but also the indirect links by which it is connected to centres with which it has no direct connection. One way of achieving such a measure is through matrix multiplication (Pitts 1965, Chorley and Haggett 1969). By raising the matrix to the power of the diameter of the graph matrix multiplication produces a solution in which all the direct and indirect links between places in the network are shown. Such a matrix is known as the 'T' matrix. Despite the fact that it overcomes the disadvantage of the simple matrix it also suffers a major weakness. The final matrix contains a number of redundancies

This is to say that edges which pass through the same vertex may be counted more than once. As Taaffe and Gauthier point out, the greater the degree of nodal clustering the greater the redundancy problem.

b. Shimbel's Shortest Path Matrix: An alternative measure of the accessibility of individual vertices on the graph is provided by Shimbel's shortest path accessibility index (1953). In the cells of the shortest path matrix (sometimes referred to as the D index) the number of edges in the shortest path between two vertices is entered. When the values for a row are added together the sum was termed by Shimbel " the accessibility of the node to the network ". It is expressed by the formula

$$A_i = \sum d_{ij}$$

where A_i is the accessibility index and d_{ij} is the number of links between place i and place j. In order to assess the accessibility of towns within Tamil Nadu this index has been calculated at both the State and the District levels.

v. Modified Topological Indices: All the measures discussed above have been purely topological indices. As such they contain no elements of distance, time or cost of movement, all of which are clearly important elements of accessibility in practice. These indices show purely structural aspects of the network. However, as Kansky (1963) has shown these indices can be modified to allow much closer approximation to the real world situation. Kansky introduces four measures incorporating distance, eta, pi, theta and iota.

a. Eta: This is simply a measure of the average edge length, expressed as M / e, where M equals the edge length and e equals the number of edges. This is a modification of the graph theoretic index eta, in which M is substituted for $\sum e + \sum v$ in the equation $(\sum e + \sum v) / e$. Clearly the index is dependent on the operational definition of the vertices.

b. Pi: Pi relates the diameter of the network to the total mileage of the system. The topological diameter is defined as the number of links or edges from one side of the network to the furthest point. This can be metricated by finding the length of these edges and incorporating them in the equation

$$Pi = C / d$$

where C is the total mileage of the transport network and d is the length of the topological diameter.

c. Theta: This index is the ratio of the length of the network as a whole to the number of vertices, and is calculated from the equation

$$Theta = M / v$$

where M is the total route length and v is the number of vertices.

d. Iota: The iota index attempts to incorporate three aspects of the network, structure, length and function. This commonly uses data relating to flows through the system (not available at a suitable scale in Tamil Nadu). However a further modification has been introduced which attempts to overcome this problem of data non-availability by substituting a weighted measure relating to the functional complexity of the vertices. In this form the equation is

$$iota = M / w$$

where M equals route length and w is the number of vertices weighted according to their function.

Not all of the modified indices suggested by Kansky are equally useful for the comparison of transport structures between regions. In this sense the regional contrasts make comparisons less viable than comparisons through time for one region. The index eta for example which measures average edge length gives an indication of the spread of the network but does not necessarily show how well the network reaches the area as a whole. Theoretically a low *eta* index shows high accessibility, the distance between the vertices being small. On this basis the two districts of the Nilgiris and Kanyakumari would be shown to have very high accessibility with *eta* indices of 7 and 10 respectively. Coimbatore and North Arcot on the other hand would be shown to have low accessibility by their relatively high indices of 20 and 23 respectively . This is demonstrably misleading, for while *edge* length tells us something of the accessibility of the vertices on the network to each other they say nothing of the accessibility of the area as a whole to the network. Thus the figures on the length of route in the shortest path matrix per unit of area provide a necessary balancing statistic. When these figures are compared the relative accessibility of the districts is reversed . On its shortest path matrix Coimbatore has 1.6 km of road for every 16 km^2, Kanyakumari and the Nilgiris 1.6 km or road for every 34 km^2.

6.5 Tamil Nadu's Accessibility Structure: the State

6.5.a Topological structure: Table 6.1 sets out the topological indices of Tamil Nadu's network structure. Figure 6.1 shows the towns included in the analysis and their distribution. The general network characteristics show an intermediate degree of connectivity. With an *alpha* index of 40% and a *gamma* index of 58% the road network conforms to Taaffe and Gauthier's *grid* pattern. Similarly the *beta* index of 1.72 shows that there is considerably more than the minimum number of *edges* necessary to link all centres to the network, although by no means complete connectivity. The topological diameter of the network is 9, that is there are nine links between the most widely separated towns on the network. This gives an indication

Table 6.1 Topological properties of the State transport network

v	=	36
e	=	62
d	=	9
u	=	27
A	=	40%
B	=	1.72
G	=	58%
Eta	=	52 miles (85 km)
Pi	=	7.5 miles (12 km)
Theta	=	90.0 miles (144 km)
Dm	=	428 miles (685 km)
$\overline{Ai}$	=	134
$\overline{C}$	=	14%

Area = 130,069 km^2

Population = 44.12 million

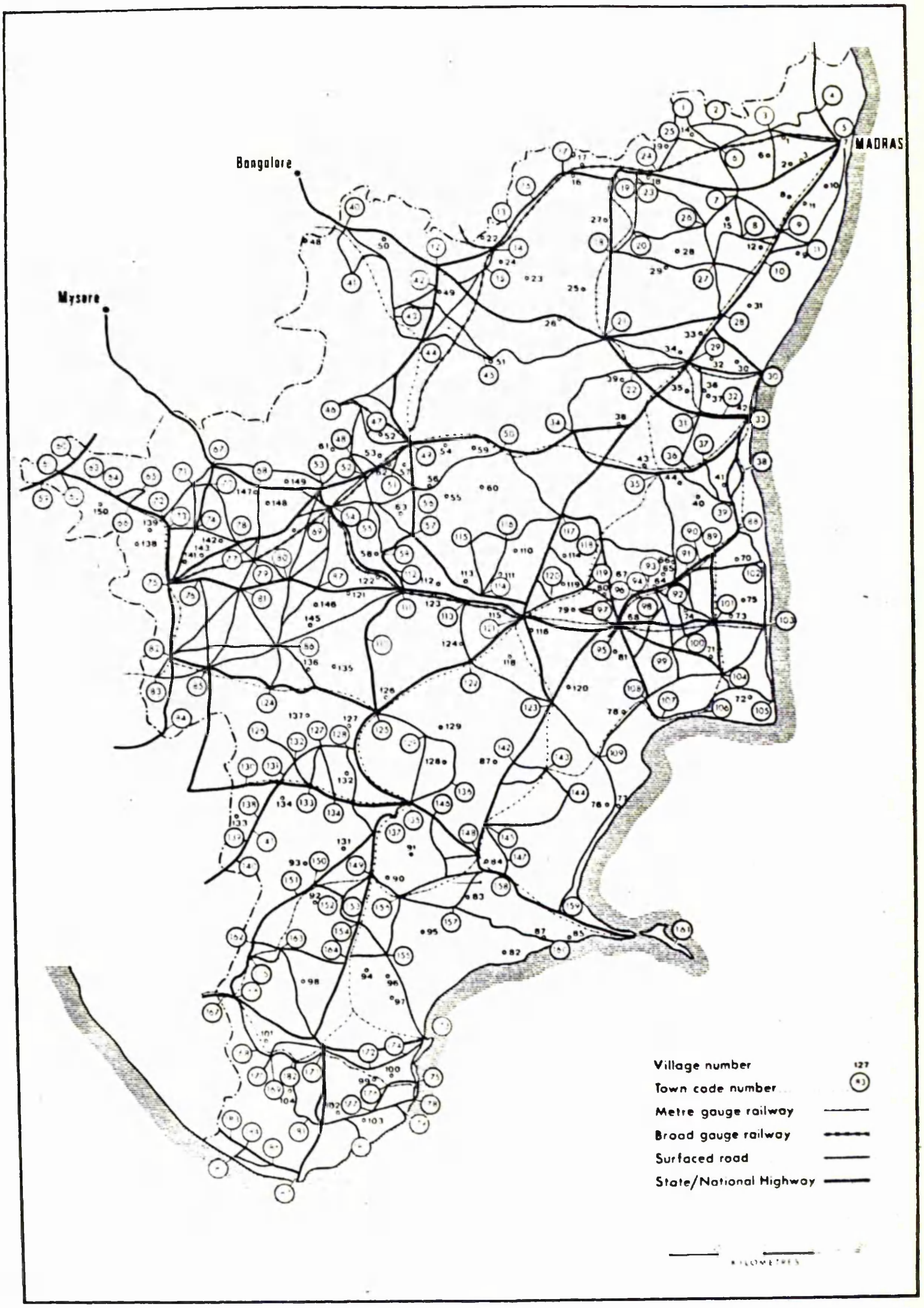
Urban Population = 12.46 million

Route length / population = 1m/13,675 (1km/8,547)

Route length/ urban population = 1 mile / 3,857 (1km / 2,410)

Key:

v	=	vertices	
e	=	edges	
d	=	topological diameter	
u	=	3 - v + p	
A	=	e - v + p / 2v - 5	(where p = the number of independent sub-graphs)
B	=	e / v	
G	=	e / 3(v - 2)	
Eta	=	M / e	(Where M = edge length)
Pi	=	C / d	(Where C = total route length)
Theta	=	C / v	
Dm	=	Length of topological diameter	
$\overline{Ai}$	=	Mean nodal accessibility index	
$\overline{C}$	=	Degree of circuity	


Bangalore
Mysore
MADRAS
Village number
Town code number
Metre gauge railway
Broad gauge railway
Surfaced road
State/National Highway
KILOMETRES

Key to town codes

1. Proddaturpet
2. Tiruttani
3. Tiruvallur
4. Ponneri
5. Madras
6. Arkonam
7. Kanchipuram
8. Uthiramerur
9. Chingleput
10. Maduranthakam
11. Tirukkulikundram
12. Krishnagiri
13. Vaniyambadi
14. Jolarpet
15. Tirupattur
16. Ambur
17. Gudiyatham
18. Polur
19. Vellore
20. Arni
21. Tiruvannamalai
22. Tirukkoyilur
23. Arcot
24. Walajapet
25. Sholingur
26. Tiruvaithipuram
27. Wandiwash
28. Tindivanam
29. Villupuram
30. Pondicherry
31. Nellikuppam
32. Panruti
33. Cuddalore
34. Kallakurichi
35. Vriddhachalam
36. Neyyveli
37. Kurinjipadi
38. Porto Novo
39. Chidambaram
40. Hosur
41. Denkanikottai
42. Kavripatnam
43. Palacode
44. Dharmapuri
45. Harur
46. Mettur
47. Taramangalam
48. Edapadi
49. Salem
50. Attur
51. Mallasamudram
52. Sankari
53. Bhavani
54. Pallipalayam
55. Tiruchengode
56. Rasipuram
57. Namakkal
58. Velur
59. Nelliyalam
60. Devarshola
61. Gudalur
62. O'Valley
63. Naduvattam
64. Ootacamund
65. Kotagiri
66. Coonoor
67. Satyamangalam
68. Gobichettipalayam
69. Erode
70. Punjai Pugalur
71. Sirumugai
72. Mettupalayam
73. Karamadai
74. Annur
75. Coimbatore
76. Sulur
77. Vellaiyampalayam
78. Avanashi
79. Tiruppur
80. Kangayam
81. Palladam
82. Palladam
83. Pollachi
84. Anaimalai
85. Valparai
86. Udumalpet
87. Dharapuram
88. Sirkali
89. Mayuram
90. Kuttalai
91. Tiruvidaimaradur
92. Kumbakonum
93. Papanasam
94 Chakkarapalli
95. Thanjavur
96. Thiruvaiyuru
97. Thirukkattuppalli
98. Ammapet
99. Mannargudi
100. Koothanallur
101. Tiruvarur
102. Tranquebar
103. Nagapattinam
104. Thiruthuraipundi
105 Vedaranayam
106. Muthupet
107. Adirampattinam
108. Pattukkottai
109. Arantangi
110. Pallipatti
111. Karur
112. Punjai Pugalur
113. Kulithalai
114. Musiri
115. Thattayangarpet
116. Thuraiyur
117. Perambalur
118. Ariyalur
119. Kalagudi
120. Lalgudi

Town codes (Continued)

121. Tiruchirappalli
122. Manaparai
123. Pudukkottai
124. Palani
125. Dindigul
126. Kodaikanal
127. Ballagundu
128. Nilakkottai
129. Nattam
130. Bodinayakkannur
131. Allinagaram
132. Periyakulam
133. Andipatti
134. Usilampatti
135. Madurai
136. Melur
137. Tirumangalam
138. Chinnamanur
139. Cumbum
140. Gudalur
141. Uthampalayam
142. Tirupattur
143. Karaikudi
144. Devakkottai
145. Sivaganga
146. Tiruppuvanam
147. Ilyangudi
148. Mannamadurai
149. Virudhunagar
150. Srivilliputtur
151. Rajapalayam
152. Tiruthangal
153. Sivakasi
154 Sattur
155. Ettaiyapuram
156. Aruppukkottai
157. Kamuthi
158. Paramakudi
159. Ramanathapuram
160. Kilakarai
161. Rameshwaram
162. Puliangudi
163. Sankaranayanarkoil
164. Kovilpatti
165. Kadayannallur
166. Tenkasi
167. Shencottah
168. Vikramasinghapuram
169. Ambasamudram
170. Manimathur
171. Tirunelveli
172. Srivaikuntam
173. Tuticorin
174. Sayarpuram
175. Kayalpattinam
176. Nazareth
177. Sattankulam
178. Tiruchendur
179. Kulasekharanpur
180. Tisayanilai
181. Eruvadi
182. Veerananallur
183. Kuzhiturai
184. Padmanabhapuram
185. Colachel
186. Nagercoil
187. Kanyakumari

extent to which direct route systems by-passing the major urban centres remains to be constructed.

Of more interest from the point of view of this study are the regional variations in accessibility within the State. Given that fantasy of the theoretical geographer's world, the isotropic surface, accessibility to the network would be expected to be greatest at the centre of the area and lowest at the periphery. Deviations from such a pattern may mean, in Lösch's memorable phrase, that " reality is wrong " ; they are however the stuff of which geography is made. The regional patterns of accessibility may be measured from Shimbel's shortest path Accessibility Index the calculation of which was outlined above. Each centre's score on this index is shown in Table 6.2, which also shows the ranks of the individual centres. Figure 6.2 maps the spatial configuration of accessibility, interpolating contours of equal accessibility.[1]

The general pattern of central and peripheral inaccessibility is confirmed. Remembering that low scores on the index suggest high accessibility, Tiruchirappalli, Dindigul, Karur, Salem and

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1. The contours are calculated on the basis suggested by Brooks and Carruthers (1953) that the number of classes should be not more than five times the logarithm of the number of observations (Haggett 1965). This rule of thumb attempts to overcome the danger of over-generalising by the use of too many contours for the data base to support while using all the data that are available. It should be noted however that the uneven distribution of centres makes the interpolation of contours difficult and at times speculative. This is particularly the case for example in the regions unrepresented by towns of 50,000, Dharmapuri and Ramanathapuram. However, although the contour map has to be treated with a degree of caution it does nonetheless give an indication of the general patterns of nodal accessibility to the State's transport network.

Figure 6.2 Spatial patterns of State-level Accessibility

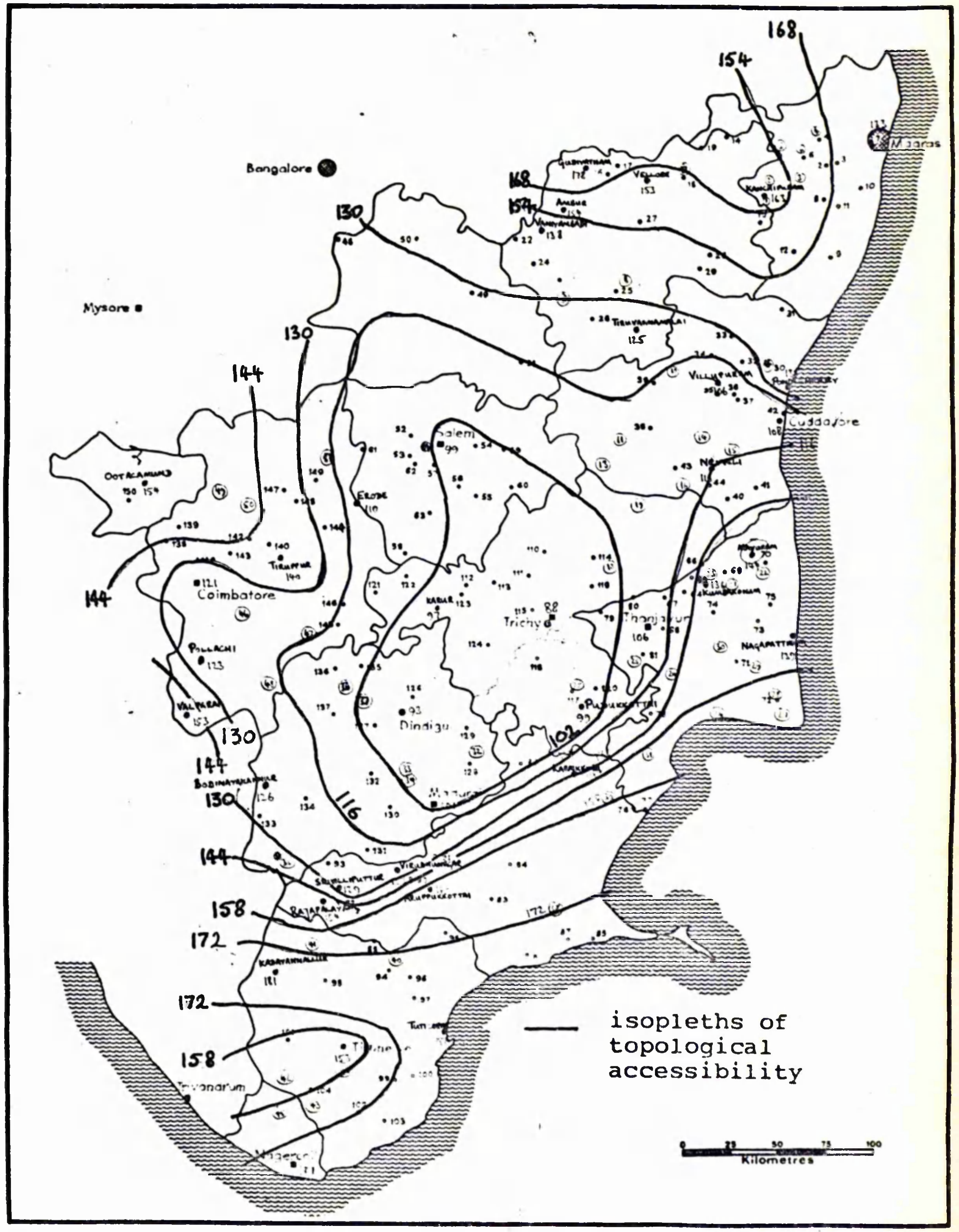


Table 6.2 Nodal accessibility at the State level

Urban nodes (Rank order accessibility)		Ai
1.	Tiruchirappalli	88
2.	Dindigul	93
3.	Karur	97
4.=	Salem	99
4.=	Pudukkottai	99
6.	Madurai	101
7.=	Thanjavur	106
7.=	Villupuram	106
9.	Cuddalore	108
10.	Erode	110
11.	Neyyveli	116
12.	Coimbatore	121
13.	Pollachi	123
14.	Tiruvannamalai	125
15.	Bodinayakannur	126
16.	Virudhunagar	127
17.	Srivilliputtur	129
18.	Madras	133
19.	Pondicherry	135
20.	Kumbakonum	136
21.	Vaniyambadi	138
22.	Nagapattinam	139
23.	Tiruppur	140
24.	Mayuram	144
25.=	Vellore	153
25.=	Tirunelveli	153
25.=	Valparai	153
28.=	Ootacamund	154
28.=	Ambur	154
28.=	Rajapalayam	154
31.	Aruppukkottai	160
32.	Kanchipuram	163
33.	Gudiyatham	179
34.	Kadayanallur	181
35.=	Tuticorin	187
35.=	Nagercoil	187

Mean Ai = 134

Pudukkottai all have scores of less than 100. Three of these four towns are in the central district of Tiruchirappalli. Away from the central core of high accessibility the slope of increasing inaccessibility is not uniform. It is steepest in the south-east and south, most gradual to the north and north-east. This pattern is a reflection of the importance of Madras in the north on the one hand and of the backwardness and inaccessibility of Ramanathapuram's eastern districts on the other.

These measures are based solely on topological accessibility. No measurement of distance is included, and thus the indices measure simply the structural pattern of the accessibility of the system. The general pattern shown by that structure is of declining accessibility away from the centre of the region interrupted only by large cities in the peripheral regions which have higher than predicted accessibility. Madras, Coimbatore and Tirunelveli all illustrate this point very clearly.

6.5.b Metricated Indices: In addition to the purely structural indices it is possible to adapt the metricated indices to Tamil Nadu. Those indices which relate to the structure of the system as a whole are shown in Table 6.2. The *eta* index is 52 miles (85 kilometres), indicating the average distance apart of the nodes by the shortest route. *Pi* (which measures the ratio of total route length to the length of the topological diameter) is only 7.55 miles (11 kilometres), which indicates that there is a relatively low surplus mileage over and above that necessary to make the minimum connections. *Theta* (relating the route mileage to the number of vertices) gives an index of 90 miles (145 kilometres) , and indicates the length of route per urban centre.

Both the topological and the metricated indices discussed above give an indication of the general properties of the State's transport system. While these give an impression of the broad patterns of accessibility within Tamil Nadu they do not allow detailed analysis of internal variations within the State. These may be looked at more closely through the metricated shortest path matrix in which the true shortest path distance is entered in the appropriate cells of the matrix (Table 6.3).

The first conclusion to be reached from a study of the metricated matrix is that the rank order of centres on the topological index is very similar to that on the distance matrix. Spearman's Rank Correlation Coefficient for the two indices yields a correlation , Rho , of 0.84, which is significant at the 99% level. This would appear to suggest that the topological accessibility pattern is very closely related to the pattern of accessibility measured by the distance matrix. However, as with much correlation analysis it is the " residuals " or the exceptions which prove interesting. In the present case these exceptions reveal some important aspects of the development of the network system. The first point of note is that the largest centres are all ranked higher along the topological scale than they are along the distance scale. This suggests that although they are peripheral and therefore inaccessible in terms of distance, structurally they are relatively well connected with each other and with the rest of the system.

The second point applies only to Madras. Its low position on both the topological and the distance matrix scores (eighteenth and thirty-fourth respectively) looks odd in the light both of its evident primacy within the State

Table 6.3 Topological properties of the railway network

Node		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Madras	1	-														
Vellore	2	1	-													
Pondicherry	3	1	1	-												
Cuddalore	4	1	1	1	-											
Salem	5	2	1	2	1	-										
Erode	6	3	2	2	2	1	-									
Tiruppur	7	4	3	3	3	2	1	-								
Coimbatore	8	5	4	3	4	3	2	1	-							
Tiruchirappalli	9	1	1	1	1	2	1	2	2	-						
Thanjavur	10	2	2	2	2	3	2	3	3	1	-					
Kumbakonum	11	2	2	2	1	2	3	4	4	2	1	-				
Dindigul	12	2	2	2	2	3	2	2	1	1	2	3	-			
Madurai	13	3	3	3	3	4	3	3	2	2	3	4	1	-		
Tirunelveli	14	4	4	4	4	5	4	4	3	3	4	5	2	1	-	
Tuticorin	15	4	4	4	4	5	4	4	3	3	4	5	2	1	1	-
		35	31	31	30	36	32	37	40	23	34	38	27	36	48	48

Of the 100,000 cities, Kanchipuram and Nagercoil are unconnected by rail.

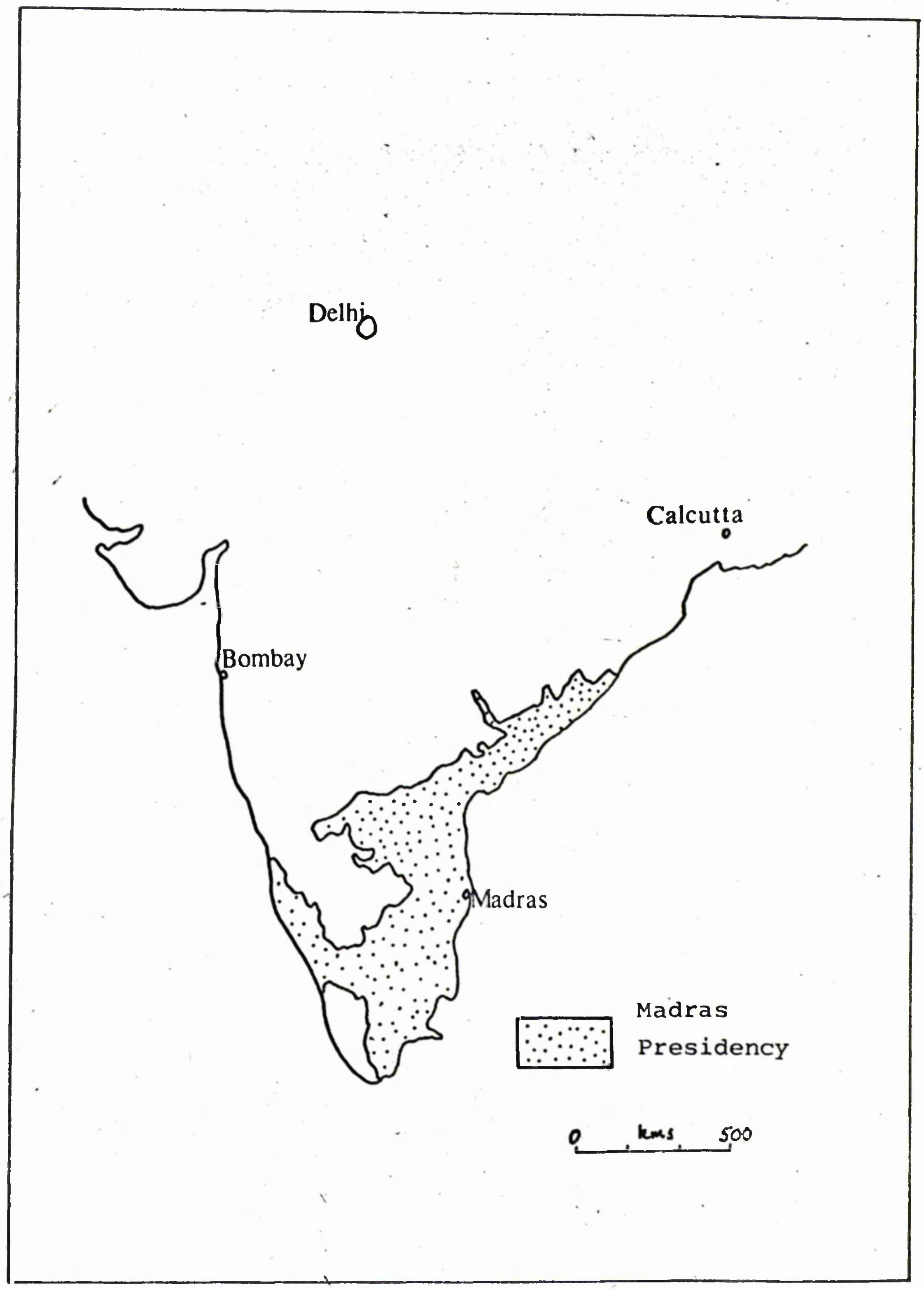
v = 17 u = 10 B = 1.41
e = 24 A = 34% G = 49%

and of its economic and administrative importance for Tamil Nadu. This can only be understood in relation to the history of the modern state of Tamil Nadu, which as was shown in Chapter Three is only the remnant of the former Madras Presidency. As can readily be appreciated from Figure 6. Madras enjoyed a position of unrivalled centrality with reference to the region of which it was the capital until 1956. Bearing in mind its extensive sea contacts along the coast it was almost equidistant between the southern tip of peninsular India and the northern limits of the Presidency on the coast of what is now Andhra Pradesh. Furthermore it was the focus of the railway network for the Presidency and the focus of routes from the cities of the south to those of the north and north-east. Its primacy in size (it being five times the size of the next largest city in Tamil Nadu) although contributed to by post-Independence expansion is fundamentally a reflection of the advantages which its development in the British period had given to it. Thus its present position at the northern extremity of modern Tamil Nadu leaves it as a " misfit " city, whose true economic hinterland, if not any longer its administrative and cultural hinterland, embraces the whole of the southern peninsula. Its rank on the topological index of accessibility can be seen as a result of the network of inter-connections focussing on Madras and raising it well above the rank that would have been expected from its location alone.

6.5.c Topological Structure of the Rail Network:

Several cities of 50,000 population are not connected with the railway system. For this reason the analysis of rail accessibility relates to nodes of 100,000 peopleonly. Of the seventeen cities in this category two (Kanchipuram and Nagercoil) are not on the railway network. Table 6.4 presents

Figure 6.3 Madras and its hinterland: the Presidency before re-organisation of the States



the topological structure of the railway network .

If only those cities that are connected directly on the rail net are taken into account both the <u>alpha</u> and the <u>gamma</u> indices suggest that there is a considerable degree of circuitry within the system (34% and 48% respectively being the index scores). The topological diameter of the network is 5, and the configuration suggests that more than the necessary number of links for minimally connected graphs are present. The ranking of the individual nodal scores shows very great similarity to that for road accessibility, which suggests that the patterns of road and rail accessibility reinforce each other.

6.6. Summary of State - level Accessibility

From the analysis of the structure of the transport network by which Tamil Nadu's towns of 50,000 and above are linked it is possible to isolate the components of accessibility. It has also been shown possible to rank centres according to their accessibility using both topological and non-topological measures. The mapping of these regional patterns has made it clear that there are pronounced contrasts within the State, even at the macro-level at which the analysis above has been carried out. At this level it has proved possible to indicate the relative accessibility of the nodes. This is potentially a considerable step forward in the understanding of the importance of accessibility of urban centres in stimulating economic change. It becomes possible not only to describe the structure of accessibility and to analyse the accessibility surface, but to use this analysis as a basis for further examination of the relationship between such structural patterns of accessibility and patterns of regional change within the system. The results of this topological analysis are used further in the subsequent examination of village level change.

6.7 District-level Patterns of Accessibility

The structure of the transport system by means of which the larger urban centres in Tamil Nadu are connected is interesting in its own right as well as being of relevance to the question of regional development. However, it is arguable whether accessibility of the transport network which focuses on towns of 50,000 or above is necessarily the only or indeed the most important aspect of accessibility with reference to regional patterns of economic change. Accessibility to district towns may also be expected to be important, and the structure of the local level transport network could well be just as significant as that of the State level network. In the analysis that follows the focus of attention is shifted to the district. In accordance with the change in scale of analysis the definition of the nodes is changed to that of urban centres with a population of 10,000 or more (see above).

6.7.a Topological Structure: Table 6.5 shows the topological indices of accessibility for the districts of Tamil Nadu. All districts have more than the minimum number of edges to make a minimally connected network. There are however considerable contrasts between them. At the lower end of the scale there are three districts that have a gamma index of less than 50% - in ascending order, Kanyakumari, the Nilgiris and Madurai. The first two districts have extremely simple, small networks with only a few vertices (five and eight respectively). In Madurai the presence of formidable physical obstacles such as the Palani and the Varushanad Hills makes interconnection difficult and

Table 6.4 . . Topological indices for district-level accessibility

	v	e	d	u	A	B	G	E	Pi	Th
Chingleput	11	19	5	9	53	1.73	61	22	5.18	37
North Arcot	19	29	8	11	33	1.53	53	23	5.47	36
South Arcot	14	22	5	9	39	1.57	55	20	4.40	32
Dharmapuri	7	11	2	5	56	1.57	58	25	3.60	40
Salem	13	24	4	12	57	1.85	65	17	5.57	32
Nilgiris	8	9	4	2	18	1.13	40	7	1.81	10
Coimbatore	22	49	5	28	72	2.23	77	20	10.08	45
Thanjavur	22	43	5	22	56	1.95	67	17	6.64	33
Tiruchirappalli	14	21	5	8	35	1.50	53	21	3.57	21
Madurai	18	25	9	8	26	1.38	49	16	3.66	22
Ramanathapuram	21	33	8	13	33	1.52	52	20	5.25	32
Tirunelveli	22	37	5	16	41	1.68	58	15	7.64	25
Kanyakumari	5	5	3	1	20	1.00	38	10	1.79	10

$u = e - v + p$

$A = (u/ 2v - 5) * 100$

$B = e / v$

$G = (e/ 3v - 2) * 100$

E (Eta) = M / e

Pi = M / d_m

Theta = M / v

Table 6. 5 Metricated indices

	Area	P	U	Dm	km	1/p	1/u	C	Ai
Chingleput	7920	2.908	1.010	79	19	7109	2471	14	21
North Arcot	12265	3.756	0.783	125	18	5491	1145	9	51
South Arcot	10898	3.618	0.513	102	28	9205	1457	12	31
Dharmapuri	9643	1.678	0.144	77	35	6057	520	10	8
Salem	8643	2.993	0.795	75	22	7673	2039	14	24
Nilgiris	2549	0.494	0.243	42	34	6500	3200	27	15
Coimbatore	15673	4.373	1.556	97	16	4472	1591	11	53
Thanjavur	9735	3.841	0.788	110	13	5261	1194	11	51
Trichy	14291	3.849	0.857	123	33	8767	1952	10	32
Madurai	12629	3.938	1.324	107	32	10046	3378	11	56
Ramnad	12578	2.860	0.747	126	19	4321	1128	11	59
Tirunelveli	11433	3.201	1.029	73	21	5736	1845	12	51
Kanyakumari	1684	1.223	0.204	28	34	24450	4349	6	7

P = population
U = urban population
Dm = length of topological diameter
km = area per mile of route
1/p= number of people per mile of route
1/u= number of urban people per mile of route
C = degree of circuity
Ai = mean accessibility index for the district

reduces the possibility of cross-linkages. In contrast, two districts, Coimbatore and Thanjavur, are classified as having <u>delta</u> configurations. Coimbatore has a high proportion of its possible routes linking places directly and also a high proportion of possible complete circuits. Thanjavur, the other district with high connectivity indices, is characterised by virtually unbroken terrain, where only the distributaries and canals of the Cauvery system present obstacles to movement. While Coimbatore is one of Tamil Nadu's most industrialised districts, Thanjavur is one of the least industrialised but one of the richest agricultural districts.

6.7.b. Metricated Indices at the District Level:

There are wide contrasts between the districts in terms of their areas and population, and in terms of the distances between nodes. It is to be expected therefore that the metricated indices would give an important and possibly different view of accessibility in the districts. The area of the districts for example varies from 1684 km^2 for Kanyakumari District to 15,673 km^2 in Coimbatore. Similarly the population varies from 0.494 million in the Nilgiris to 4.373 million in Coimbatore. These contrasts make the comparison in terms simply of non-metricated topological indices far more difficult.

In view of these points it is not surprising that the metricated indices introduce some changes in the ranking of the districts in terms of their accessibility. The different metricated indices all reveal a similar pattern, however, and there is a very close degree of correspondence between the indices. The scores on each index and the mean rank for the districts are shown in Table 6.5. Although ranking loses some of the information it makes possible direct comparisons between the districts. The spatial patterns that emerge are shown in Figure 6.4, which shows the distribution of mean ranked scores.[1]

Pi (which measures the length of the route on the shortest path network in relation to the length of the diameter) is low when there is little " surplus " routeway, high when the " surplus " is great. As such it shows strong similarity to the topological indices of alpha and gamma, which measure topologically " redundant " routes. On the pi index Coimbatore, Tirunelveli and Thanjavur score highly; Kanyakumari, Tiruchirappalli and the Nilgiris have low indices.

Theta illustrates the difficulties of comparing networks which cover very different sized areas. It measures the ratio of route miles to the number of vertices. Small networks (Kanyakumari and the Nilgiris) have low scores, large networks (Coimbatore and North Arcot) have high scores. These scores conform to the predicted pattern of high accessibility being measured by high indices. Dharmapuri also has a high index score (ranking second on the theta index), but in this case the index reflects the large area and the very small number of vertices. These vertices are therefore far apart and the route mileage in relation to the number of vertices is correspondingly great.

Despite the slight instability of some of the indices which the above discussion suggests the general pattern is clear. The districts

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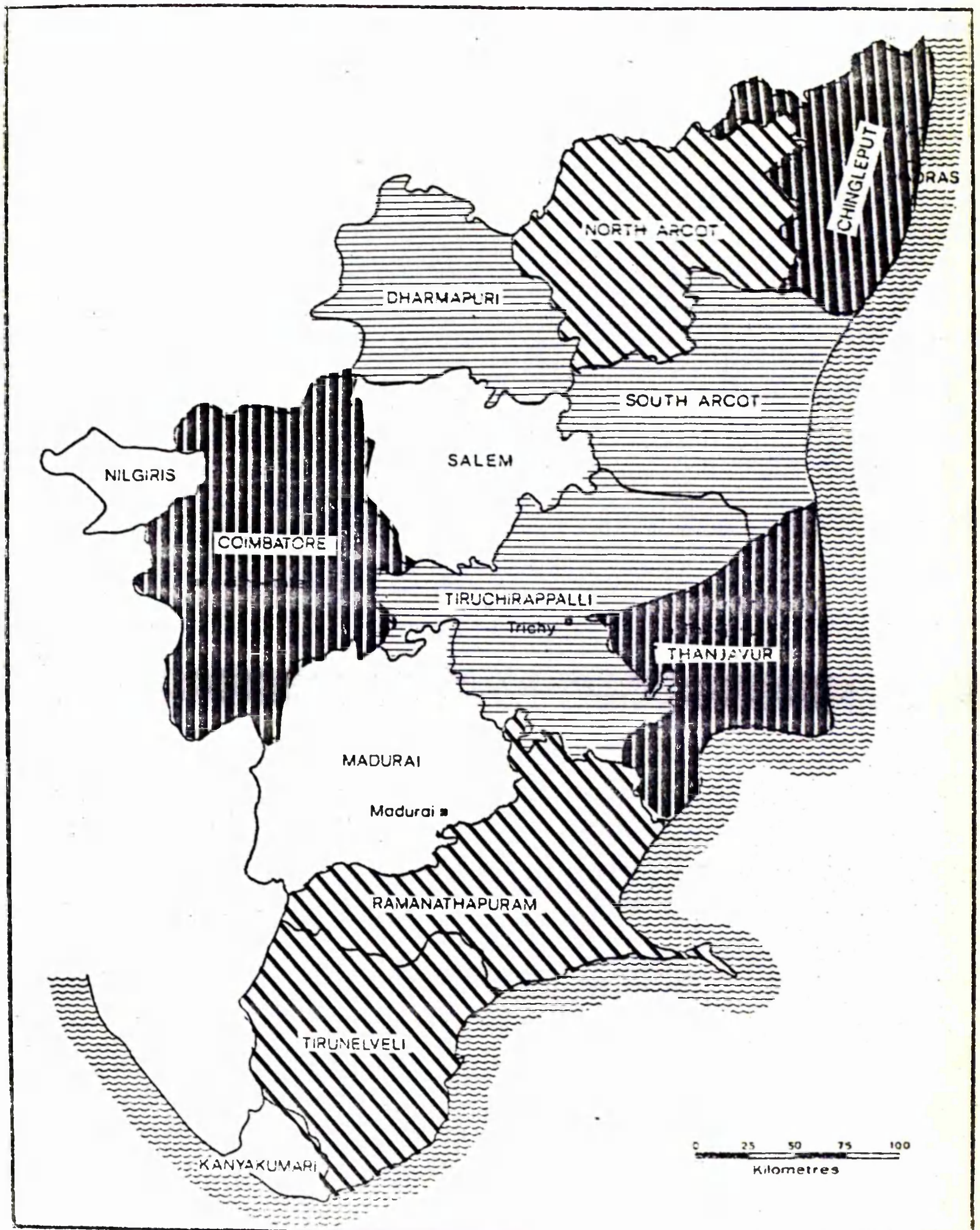
1. This procedure is only meaningful when the indices show broadly the same picture. This is indicated by the high correlation between the indices chosen - alpha, gamma, pi and theta, and the density of the route network.

can be grouped according to their accessibility scores into quartiles. The resulting pattern is shown in Figure 6. 4 . The most striking feature of the distribution of highly ranked scores lies in its dissimilarity with the accessibility pattern found to hold good at the State level. The districts with the highest degree of internal connectivity are those of Coimbatore, Thanjavur and Chingleput. Coimbatore ranks furst on four of the six indices used. Both Coimbatore and Chingleput are peripheral to the State transport networks, while Thanjavur, despite its relative locational centrality was also relatively poorly connected with the State network. In contrast the districts of Tiruchirappalli and Madurai, which ranked highest in the general accessibility pattern for Tamil Nadu are amongst the lowest ranked districts in terms of their internal accessibility structure.

This contrast between the accessibility of the State's major cities among themselves and the regional accessibility patterns of the local transport networks may be expected to be significant to a varying degree for different types of economic activity. It makes clear the validity of the proposition that it is essential to define precisely what is meant by accessibility if any attempt is to be made to analyse its importance in regional development.

It is beyond the scope of this Chapter to examine in depth the reasons for regional contrasts in accessibility of the sort indicated. However, some of the more important reasons should be outlined as they are pertinent to the subsequent discussion.

The two districts least well served by their mean ranked scores



SOAS Drg No 85

a f de souza

Uppermost quartile

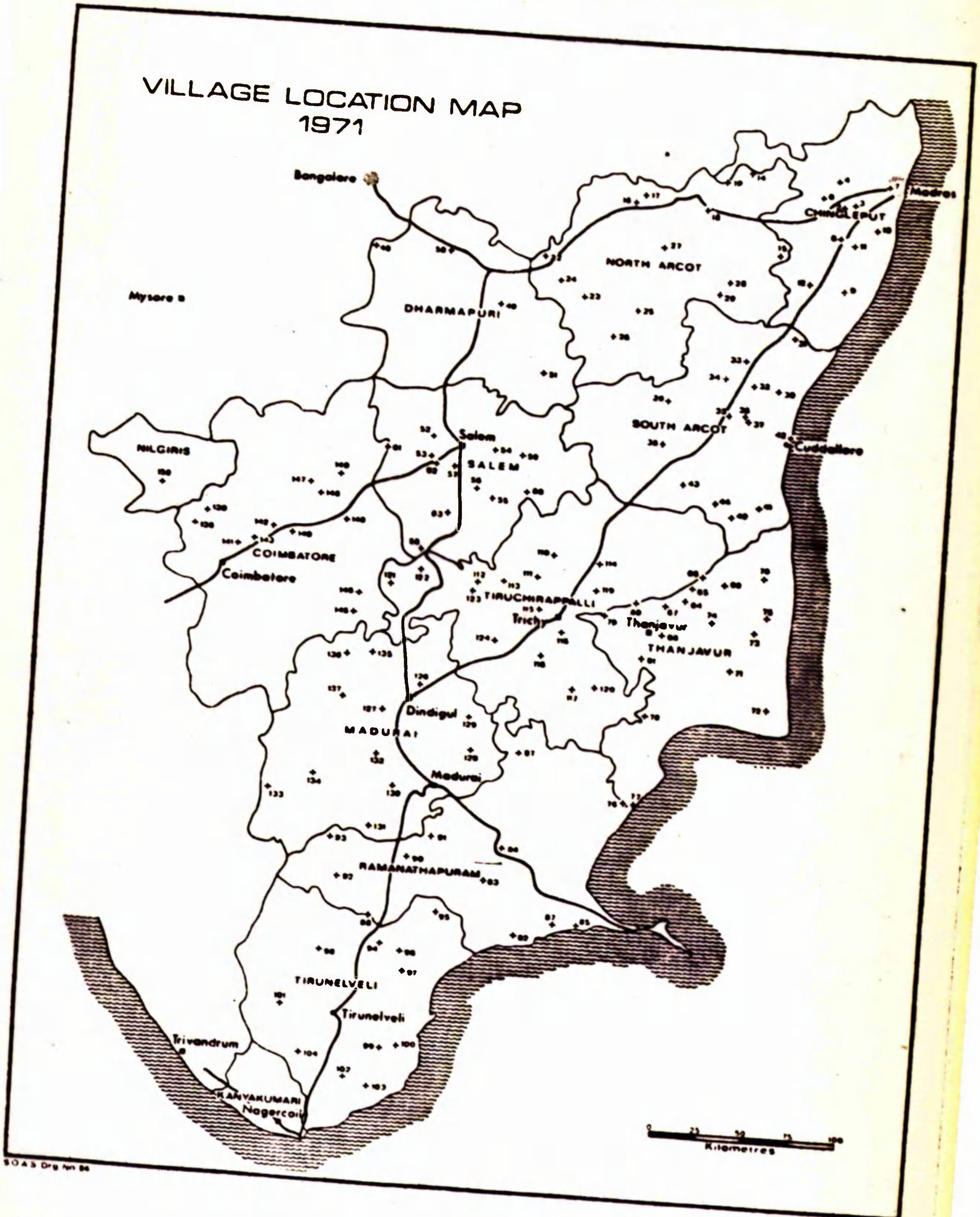
Lower-middle quartile

Upper-middle quartile

Lowest quartile

local transport networks are Kanyakumari and the Nilgiris. By far the smallest districts, they contrast with each other in some important respects. The Nilgiris, as was shown in Chapter Three, are a mountainous tract, relatively sparsely populated and until the nineteenth century populated almost exclusively by hill tribes. Subsequent development of the district as a hill resort for Europeans to avoid the worst of the hot weather saw the development of several small urban centres - Ootacamund being the largest, followed by Coonoor, Wellington and Kotagiri. Accompanying these changes there occurred an agricultural revolution with the spread of plantation agriculture. These two developments led to the growth of a small and concentrated group of settlements in the middle of a very sparsely populated area. It rapidly became the most urbanised district in the State, and in 1951 almost 50% of its population was classified as urban. The difficulty of the terrain is among the factors ensuring that only the minimum number of routes necessary to link the urban centres would be constructed, and this has contributed to its low scores on all the indices except that of length of road per capita of population.

Kanyakumari by contrast is the most densely populated district in the State, with nearly twice the density found in Thanjavur, its nearest " competitor ". In this, as in its physical environment, it resembles neighbouring Kerala more than Tamil Nadu (to which it was only joined in 1956). Its settlement pattern also contrasts markedly with that found in the rest of the State. Dispersed settlement rather than nucleated villages and a very low percentage of the population living in towns (16%) are its chief characteristics. The very few towns are spread almost in a line through the district, and the minimal network suffices



VILLAGE LOCATION MAP
1971

to meet the needs for interaction demanded by the predominantly subsistence agricultural economy.

The reasons for the low rank of Madurai have already been discussed briefly above. Tiruchirappalli comes very low on the ranking partly as a result of the fact that the River Cauvery bisects the district and is only bridged at Tiruchirappalli itself. Thus the southern part of the district can only connect with the northern part through the city of Tiruchirappalli, which gives the city its completely predominant centrality. This centrality enhances that of the city to the wider network of Tamil Nadu, and makes it a key nodal point within Tamil Nadu's transport network. No other district illustrates so clearly the contrast that may exist between accessibility at different scales within the same region.

At the high end of the accessibility scale come Coimbatore, Thanjavur and Chingleput. Coimbatore has had a rapid development of its engineering industries alongside the cotton factories which sprang up during the inter-War cotton boom. This development of large-scale cotton mills involved many areas of the surrounding region in the production of cotton. Post-Indpendence development of large-scale irrigation projects such as the Lower Bhavani scheme have also brought rich rewards to some parts of the district, and it has a very rapidly developing economy. In addition it has a relatively long standing urban history, with some large regional market centres such as Pollachi and crossing points of the Cauvery such as Bhavani and Erode that have acted as nuclei in the development of a transport system. Lying across the entrance to the only gap through the Western Ghats to the west coast for 300 miles (500 kilometres) in any direction, it has commanded the route from the west coast through to the southern part of peninsular India since the contact of the Romans. Thus its role as an inter-regional transport nodal region is superimposed on its local network to give it very high indices of accessibility.

Chingleput district is the hinterland for Madras City. Hence its high ranking may be seen in part at least as a reflection of the proximity of the largest city in South India. The passage through the district of all the major roads linking Madras with the south, south-west, west and north give to the district what may be termed " derived accessibility ".

Of the intermediately ranked districts only Dharmapuri deserves special comment. This is by virtue of the fact that on most indices of economic development it comes at the bottom of Tamil Nadu's ranking. The question is therefore raised: if development and the structure of accessibility are linked what underlies Dharmapuri's relatively high accessibility scores? Close examination shows that in this district more than in any other the indices themselves must be seen in the context of the character of the region. By far the least densely populated district in Tamil Nadu (174 per sq.km.), and also by far the least urbanised (8.5%),the network is very small bearing in mind the total area which the district covers. Thus while the vertices themselves are relatively well connected with each other their accessibility to the rest of the district is poor. This accessibility cannot be measured by topological indices, but is suggested by the fact that it has the lowest ranking of all the districts in terms of its density of roads per unit of area, perhaps the most significant single indicator of the accessibility of the surrounding region to the network. Thus its high rankings on the alpha and gamma indices which show the nodal network to be relatively highly interlinked must be viewed in the context of the other aspects of its accessibility structure.

6.7.c Nodal Accessibility: The absolute accessibility indices for individual nodes are not directly comparable throughout the State . This is because the results of the nodal accessibility index are conditioned by the size of the matrix. The larger the matrix the greater will be the number of links between one place and all other places, even in a completely connected graph. Thus it is not possible to compare directly, for example, the accessibility index of a town in the Nilgiris with that of one in Coimbatore, when the number of vertices in the first case is only eight while in the second it is forty-nine. It would only be possible to compare the accessibility of nodes within the State as a whole were all the nodes at the district level being analysed within one regionalunit. However, despite this limitation it is possible to compare the accessibility of various nodes within any given district. The rankings of all the towns with a population greater than 10,000 are set out in Table 6.7.[1]

By standardising the accessibility indices it is also possible to derive comparability between districts. This can be achieved by a simple modification to Shimbel's Accessibility Index, A_i , converting the index for each node into

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1. Some towns were on or very near the borders of two districts. These were included in both district networks.

Table 6.6 Rank order nodal accessibility: District level

Chingleput	I_{tc}
1.= Tiruvallur	160
1.= Madras	160
1.= Kanchipuram	160
4. Chingleput	180
5. Arkonam	190
6.= Ponneri	210
6.= Uthiramerur	210
8.= Tirutanni	230
8.= Tirukkulikundram	230
10. Madurantakam	250
11. Proddaturpet	320

North Arcot	
1. Polur	217
2. Vellore	228
3.= Arni	239
3.= Wandiwash	239
5.= Tiruvannamalai	256
5.= Arcot	256
7. Tindivanam	267
8. Ambur	272
9. Kanchipuram	283
10= Gudiyatham	294
10= Tiruvathipuram	294
12. Vaniyambadi	300
13. Walajapet	306
14. Krishnagiri	311
15. Tirukkoyilur	339
16. Jolarpet	344
17= Tiruppattur	389
17= Arkonam	389
19. Sholingur	450

South Arcot	
1= Pondicherry	215
1= Cuddalore	215
3= Villupuram	223
3= Tirukkoyilur	223
5 Panruti	230
6= Nellikkuppam	238
6= Kallakurichi	238
8= Vriddhachalam	254
8= Kurinjipadi	254
8= Tindivanam	254
11= Porto Novo	262
11= Chidambaram	262
13 Neyyveli	277
14 Tiruvannamalai	292

Dharmapuri	I_{tc}
1. Palacode	117
2. Kaveripatam	133
3.= Hosur	150
3.= Dharmapuri	150
3.= Harur	150
6.= Denkanikkottai	167
6.= Krishnagiri	167

Salem	
1. Salem	158
2. Sankari	175
3.= Mallasamudram	192
3.= Rasipuram	192
5.= Edapadi	208
5.= Pallipalayam	208
7.= Namakkal	217
7.= Bhavani	217
9. Mettur	225
10.= Attur	233
10.= Tiruchengode	233
12. Taramangalam	242
13. Velur	275

Nilgiris	
1.= Gudalur	171
1.= Naduvattam	171
3. Ootacamund	200
4.= Nelliyalam	243
4.= Devarshola	243
6. O'Valley	257
7.= Kotagiri	271
7.= Coonoor	271

Coimbatore	
1. Coimbatore	200
2. Pollachi	214
3. Gobichettipalayam	224
4. Palladam	229
5.= Erode	233
5.= Annur	233
7. Bhavani	238
8. Avanashi	243
9. Sulur	248
10.= Punjai Pugalur	252
10.= Vellaiampalayam	252
12. Tiruppur	262
13. Kangayam	267
14.= Udumalpet	271
14.= Dharapuram	271
16. Karamadai	276
17. Satyamangalam	281
18. Vellakoyil	286
19 = Sirumugai	290
19.= Anaimalai	290
21. Valparai	305
22. Mettupalayam	329

Key:

I_{tc} = Index of topological circuity. See text .

(Continued)

Table 6.6 (Continued)

Thanjavur		I_{tc}
1.	Tiruvarur	171
2.	Tiruthuraipundi	190
3.	Ammapet	195
4.	Mannargudi	205
5.=	Koothannallur	210
5.=	Pattukkottai	210
7.=	Thanjavur	224
7.=	Nagapattinam	224
9.	Papanasam	243
10.	Tranquebar	248
11.	Kumbakonum	252
12.=	Kuttalam	257
12.=	Chakkarappalli	257
14.=	Tiruvadaimarudur	262
14.=	Vedaranayam	262
16.	Mayuram	267
17.	Muthupet	271
18.	Adirampattinam	290
19.	Tirukatipattu	295
20.	Arantangi	305
21.	Tiruvaiyaru	314
22.	Sirkali	343
Tiruchirappalli		
1.	Tiruchirappalli	162
2.=	Kulithalai	208
2.=	Thuraiyur	208
2.=	Perambalur	208
5.=	Musiri	231
5.=	Lalgudi	231
7.=	Manaparai	246
7.=	Pudukkottai	246
9.	Karur	269
10.	Kalagudi	277
11.	Ariyalur	285
12.	Thattayangarpet	292
13.=	Pallipatti	362
13.=	Punjai Pugalur	362
Madurai		
1.	Andipatti	241
2.	Ballagundu	253
3.	Usilampatti	259
4.=	Allinagaram	271
4.=	Periyakulam	271
6.	Nilakkottai	276
7.	Madurai	288
8.	Tirumangalam	300
9.	Chinnamanur	329
10.	Dindigul	341
11.	Kodaikanal	347
12.	Nattam	353
13.=	Bodinayakkannur	365
13.=	Melur	365
15.	Uthampalayam	400
16.	Palani	435
17.	Cumbum	488
18.	Gudalur	571

Ramanathapuram		I_{tc}
1.=	Tiruppuvanam	225
1.=	Manamadurai	225
3.	Aruppukkottai	230
4.	Sivaganga	240
5.	Kamuthi	250
6.	Paramakudi	255
7.	Madurai	260
8.	Virudhunagar	265
9.	Devakkottai	300
10.=	Ettaiyapuram	305
10.=	Ilyangudi	305
12.=	Karaikudi	310
12.=	Kilakarai	310
14.	Ramanathapuram	320
15.=	Tirupattur	330
15.=	Tiruthangal	330
17.	Sattur	340
18.	Srivilliputtur	345
19.	Sivakasi	405
20.	Rameswaram	420
21.	Rajapalayam	440
Tirunelveli		
1.	Tirunelveli	152
2.	Sattankulam	205
3.=	Tenkasi	214
3.=	Nazareth	214
3.=	Tuticorin	214
6.=	Sankaranayanarkoil	219
6.=	Eruvadi	219
8.=	Kovilpatti	224
8.=	Veerananallur	224
10.	Ambassamudram	229
11.	Srivaikuntam	238
12.=	Kayalpattinam	271
12.=	Tiruchendur	271
14.=	Kadayanallur	281
14.=	Kulasekharampalayam	281
16.=	Ettaiyapuram	286
16.=	Tisayanilai	286
18.	Vikramasinghapuram	286
19.	Sayarpuram	300
20.	Puliangudi	305
21.	Shencottah	310
22.	Manimathur	324
Kanyakumari		
1.=	Nagercoil	125
1.=	Padmanabhapuram	125
3.	Colachel	150
4.=	Kuzhiturai	200
4.=	Kanyakumari	200

a percentage of the minimum number of links necessary to connect each node directly with all the other nodes. Thus the minimum number of edges necessary to connect one vertex in the network with all other vertices is given by $n - 1$, where n = the number of vertices. This standardised index, which may be termed, albeit somewhat inelegantly, the index of topological circuity, is thus obtained from the formula

$$I_{tc} = A_i / A_{i\ min} \times 100$$

where $A_{i\ min} = n - 1$.

Every node on the network thus has its accessibility to its own network expressed not in absolute terms but in terms of the degree of circuity of its shortest path connections with all the other nodes in its own network.

The I_{tc} indices for all the nodes are shown in Table 6.7. One of the striking if not entirely surprising features of the ranking according to accessibility of Tamil Nadu's towns is the extent to which district administrative headquarters come near the top of the centrality " league ". In five of the thirteen non-metropolitan districts the district headquarters is also the most accessible town. These are Salem, Coimbatore, Tiruchirappalli, Tirunelveli and Kanyakumari. In a further five the district headquarters are among the three most accessible centres (Chingleput, North Arcot and South Arcot, the Nilgiris and Dharmapuri).

There are some interesting contrasts between the districts in the extent to which there is similarity in the districts' nodal accessibility. In five of the districts, for example, no one node enjoys a clear advantage. In Chingleput three centres share the highest degree of accessibility. In South Arcot, the Nilgiris

Ramanathapuram and Kanyakumari two centres are equally accessible to the network. In sharp contrast, two districts show a pronounced difference in accessibility between the most accessible and the second most accessible centres. These are Tiruchirappalli (a difference of 46% between the first and second ranked centres) and Tirunelveli (a difference of 53%).

A comparison of the indices also makes possible some interesting conclusions as to the range of accessibility within districts. By looking at the difference between the minimum and the maximum scores on the I_{tc} index it is possible to establish the range of accessibility within each district. In the small networks of Dharmapuri and Kanyakumari the range is as low as 50% and 75% respectively. Low ranges are also found in South Arcot (77%), the Nilgiris (100%), Salem (117%) and Coimbatore (129%). In none of these districts is the difference in accessibility between the most and the least accessible centres much greater than two times. Thus all the centres within these networks can be seen as being relatively well connected with their own district level transport system. In contrast there are three districts where the range is 200% or more - Tiruchirappalli (200%), Ramanathapuram (215%) and Madurai (330%).

These contrasts in nodal accessibility serve to highlight the major differences that exist in the topological structure of the district level networks of road communication that exist within Tamil Nadu. These differences have been evidenced further by the series of metricated indices which have been applied, and which have suggested important contrasts not only between the districts but also between the patterns of nodal accessibility found at the district and the State levels.

6.8 Conclusion

Garrison and Marble (1961) and Kansky (1963) showed that it was possible to relate general indices of network structure to levels of economic development. It is not the purpose of this thesis to attempt any such analysis in the context of Tamil Nadu. However, the development of standardised indices of network structure and of nodal accessibility does make possible the testing of hypotheses in which socio-economic change at a village level is related to urban accessibility. For once local accessibility has been defined it becomes possible to operationalise the hypotheses and to analyse the part which such accessibility may play in influencing the spatial and regional organisation of such change. Thus while the analysis of the structure of Tamil Nadu's transport system discussed in this Chapter may stand in its own right as an introductory and very partial discussion of the transport network, it also lays the foundation for the analysis of village level change which is the main focus of the remaining chapters.

CHAPTER SEVEN

Accessibility and Innovation: the Role of Towns and Cities

7.1 Introduction

In the previous Chapter some concepts of accessibility were clarified. The remainder of this thesis examines in greater detail the nature of the relationship between accessibility and village level patterns of change in agriculture and in some aspects of economic life.

It is clear from the previous Chapter that although considerable progress has been made in the definition of structural aspects of network accessibility and of nodal accessibility within networks, the links between such accessibility measures and economic and social change remain tenuous. A particularly strong attack on the current interpretative inadequacies of network analysis has been made by Hay (1973). This final part of the thesis attempts to advance a little further the empirical testing of the relevance of such analysis.

The first sections of this Chapter examine the nature of the relationships that may be predicted between accessibility and development and the adequacy of the techniques available for their analysis. The succeeding sections present an analysis of the patterns of relationship within Tamil Nadu and discuss the spatial organisation of agricultural and economic change within the State with special reference to the impact of urban centres.

7.2 The Hypotheses

The spatial patterns of social and economic change are highly complex, and reflect the interaction of a number of widely different factors. Despite this evident fact, some spatial regularities may be expected. For example, technological change in agriculture which has played a vital role in Tamil Nadu's economic development in both the immediate past and over a longer time period has been closely related to what may be termed " urban-centred technology " (Techno-Economic Survey for Madras 1965, Tamil Nadu Economic Survey 1971). The introduction of chemical fertilisers and high yielding varieties of seeds, the spread of electric pumpsets and the introduction of some forms of agricultural mechanisation have all emanated from urban centres. Such centres have served both as points of production and of marketing. Thus from the villagers' point of view the urban centre may be seen as the point of origin for physical inputs which form a basic part of new agricultural technology.

Non-agricultural innovations have an even clearer association with urban centres, and transistors, scooters, bicycles, stoves and other consumer goods which are beginning to penetrate to the remotest parts of Tamil Nadu are all distributed through towns.

With these points in mind there is a large body both of theory and of empirical evidence to suggest that transport cost is an element of final price which may play a role in the ability and willingness of the potential consumer of a product to purchase it. The " friction of distance " may be effective not only through its direct effect on price but through its effect on the dissemination of information.

The nature of the relationship between distance from urban centres and a number of economic or social indicators has often been assumed to be linear, reflecting the assumption that transport costs themselves are a linear function of distance. (Von Thünen's model of agricultural location is the classic example of the statement of this principle.) In practice transport costs are rarely a simple linear function of distance (Taaffe and Gauthier 1973), and modified linear relationships have been found to give a closer approximation to reality. Thus the logarithmic transformation of distance has been shown to be of relevance in a number of studies relating the spatial organisation of variables such as population distribution, migration and commodity flows around urban centres (Bradnock 1973, Clark 1947).

The spatial pattern which results from the impact of the friction of distance on such phenomena as the dissemination of new techniques and the availability and use of consumer goods within villages is undoubtedly complex. However, if distance from urban centres plays any part in the spatial form of agricultural change and economic development such an influence should be reflected in the villages. Thus the first general hypothesis may be stated in the following terms: that the " friction of distance " from urban centres is a significant factor in the dissemination and adoption of agricultural techniques and has a significant impact on the patterns of economic change. In the simplest form of this hypothesis, in which distance from an urban centre would be taken as a surrogate variable for cost of transport, the more remote villages would be expected to show less evidence of change than those close to urban centres. It is clear that the applicability of distance as a substitute variable for cost is by no means always straightforward. The cost of distance, for example, is not necessarily reflected in the commodity price, for most of the agricultural commodities relevant to this study (fertilisers, high yielding varieties of seed, and even pumpsets) are sold at a standard price irrespective of location. However, it would reflect the indirect costs to the farmer of getting to the distribution centre and of transporting the commodity back to the village.

It is clear that the " friction of distance " can only be one among several factors influencing agricultural and economic life. Some of these other factors are discussed in more detail below. However, in addition to the variability which attaches to the importance of distance per se, it must also be accepted that towns themselves are not uniform in their characteristics and may therefore be expected to exert variable degrees of influence over their hinterlands. This variability may be systematic just as the impact of distance itself may be systematic. For example, the spatial distribution of some commodities and consumer goods may reflect the influence of distance from large cities while others reflect the importance of small market towns. Similarly, the widespread nature of Government distribution centres for high yielding varieties of seed, in which as was shown in Chapter Five the Block Development Headquarters act as distribution centres to villages, makes it probable that it is at the local level that the impact of distance will be most keenly felt, and that therefore the role of relatively small towns in the distribution of high yielding varieties of seed may be more important than that of the largest cities. For other commodities such as bicycles and transistors on the other hand , where centres of production are very limited and where distribution takes place primarily through the largest cities and is then filtered down through the smaller towns, distance from the largest cities may be expected to be of greater importance.

From this line of reasoning the second general hypothesis may be advanced. This states that the impact of the urban centres will vary according to their size and functional complexity, and that correspondingly different facets of agricultural and economic change will show differing degrees of orientation to urban centres according to their size. In view of the discussion in the previous chapter, this hypothesis may be broadened to include reference to the structural characteristics of accessibility. Thus in this Chapter an analysis is made of the importance of some of these aspects of accessibility.

Throughout, the emphasis is placed on the analysis and interpretation of village - level change. The fundamental question asked is whether the location of a village relative to urban centres and relative to its generalised accessibility has a bearing on the nature and degree of its agricultural and economic change. Having established this as the basic aim, however, it is also necessary to ask what other factors are involved and to what extent they are amenable to analysis. Referring back to Chapter Four we can see that many elements of the agricultural system have a bearing on the nature , pace and degree of change. From the physical environment, quality of soils and availability of water, through to aspects of the social structure, land ownership and tenancy patterns, the inter-relatedness of the processes of change poses one of the major problems in any attempt to disentangle the complex patterns. It is abundantly clear that whatever the importance of distance from urban centres should prove to be, it is most unlikely that more than a small proportion of the variance in the data will be explained by this one factor alone. Thus while the first task of this and the next Chapter is to determine whether urban centres do exert influence over the spatial organisation of change, the second major aim is to examine the rôle which other factors play.

Such an analysis is inevitably constrained by the limitations imposed by the overall structure of the study and by the limitations of the data. However, even within these constraints it is possible to examine the influence of non-spatial factors upon the patterns of change. On the one hand there is a range of environmental factors whose significance it may be hypothesised is considerable. The most notable of these is the availability of water supplies, whose importance in terms of the willingness of farmers to invest in the new technology has already been pointed out. Similarly, a number of other influences have been held to be important. Epstein (1957, 1971) points to the importance of caste structure on village level patterns of change in South India. Equally literacy has also been widely held to be a significant factor in adoption/non-adoption patterns, a belief reflected in the importance attached by the Government to literacy programmes.

Thus the third general hypothesis may now be stated: that while distance from urban centres may be expected to play a part in producing patterns of regional differentiation in agricultural and economic change, the role of other social, economic and environmental factors may also be expected to be significant. In this generalised form this hypothesis states no more than is obvious. However, it opens up the possibility of exploring the exact importance which elements other than distance may have for the spatial patterning of change within a region, and specifically within Tamil Nadu. It is immediately apparent that such a hypothesis has to be broken down into its component parts before any meaningful interpretation can be made. Furthermore, not only is the influence of some factors not measurable with the statistical data available (which places a particularly heavy burden on inferential techniques of analysis and on the use of surrogate variables), but the role of factors such as caste or " social dynamism " are simply not amenable to more than the most elementary analysis using the approach followed in this study. The problems of such analysis are discussed further below.

7.3 The Methods of Analysis

In the first stage of analysis an attempt is made to assess whether there is a significant degree of orientation shown by patterns of village development to urban centres of different sizes. The method chosen is that of partial correlation analysis.

The most significant advantage of partial correlation analysis lies in its ability to discriminate between variables which show consistent and significant relationships when other variables are held constant. Starting from a simple correlation matrix (which may be based on either parametric or non-parametric correlations) partial correlation analysis allows the stability of the significant correlations to be tested by holding any or all of the other variables within the data set constant. This allows any " controlling " effects to be eliminated, removing spurious correlations and also making possible the clarification of relationships which may be obscured until variables which have conflicting relationships are held constant (SPSS 1975). For example, it may be found that there is a significant negative correlation between distance from a town of 20,000 and the use of high yielding varieties of seeds. It may also be found that there is a negative relationship between distance from towns of 100,000 and the adoption of high yielding varieties of seeds. In such a situation it may be suspected that the former is a spurious relationship , particularly if distance from towns of 20,000 is positively correlated with distance from cities of 100,000. Partial correlation analysis allows the " stability " or reliability of such relationships to be tested by holding each variable constant while allowing the other two to vary (Nie et al 1975).

Although this illustration only points to the possible interaction betwen three variables, partial correlation analysis is capable of handling much greater complexity. It is of course subject to the same constraints as any statistical analysis; it is dependent on the data put into the analysis. Furthermore, the variables capable of being controlled are only those for which data are available. There is no way in which influence of variables outside the data set can be controlled or allowed for Perhaps the most important of these in the context of the present study is that of income, for which no data are available.[1]

1.It was intended to use National Sample Survey data on income levels, based on the 23rd Round Survey. It will be recalled from Chapter Three that it was partly for this reason that the National Sample Survey sample villages were used. Unfortunately, despite repeated efforts to obtain them these data were never made available.

The influence of income on the use of new technological inputs may be expected to be considerable, yet it cannot be directly assessed. An additional problem lies in the assumed linearity of the relationships under examination While as has been shown above there is some theoretical justification for testing for the linearity of relationships, it has to be borne in mind that alternative polynomial forms of relationship between variables cannot be ruled out. The present analysis simply seeks to establish whether or not linear relationships exist between variables, first between distance from urban centres, accessibility of networks and agricultural and economic change; secondly between demographic and social variables and agro-economic change.

7.4 Accessibility Measures

The measurement of accessibility has been discussed in some detail in the previous chapter. In addition to the measures discussed there seven other measures of accessibility are used in this analysis. The indices of accessibility outlined in the last chapter related to the structural properties of the transport systems. However, it is also desirable to examine the importance of accessibility to towns with a view to analysing the direct impact of cities on the patterns of technological change under investigation. These measures are set out below.

1. Distance from towns in the size class 20,000 to 100,000. In 1971 there were 84 towns in this category.
2. Distance from towns in the size category 100,000 to 1,000,000. There were fifteen such towns in 1971.
3. Distance from towns of 1,000,000 and above. There are only two such cities with direct influence over the region, Madras and Bangalore.

4. Distance to the nearest weekly market.
5. Distance to a bus stop.
6. Distance to a railway station.
7. The number of travellers from the village per day.

The first four of these measures[1] reflect direct accessibility to centres of distribution for various new commodities, important both as consumer goods in villages and as agricultural inputs. Distance is measured by the shortest road route. It does not attempt to incorporate refinements such as the cost of transport by alternative means or the availability of alternative routes, except in the case of distance to the nearest market. As the great majority of travellers to weekly markets go on foot and travel by footpaths, distance is measured by shortest footpath route.

The use of relatively simple road distance is justified by the ease of calculation, but inevitably its lack of refinement leaves something to be desired. There is no necessarily perfect correlation between distance and cost of travel, or even between distance and length of journey time or frequency of opportunity to travel, all of which may well be important. Some attempt is made to counteract these disadvantages by analysing the importance of three measures which reflect such an indirect linkage with urban centres. These are distance from a bus stop, the number of buses per day and distance from a railway station. In addition an attempt was made to assess the degree of contact between the village and other centres by establishing the number of daily journeys

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1. In the subsequent discussion the town groups are referred to by the shorthand convention "20,000 towns","100,000 cities" and "1,000,000 cities" .

from the village. Although the data obtained in this respect were much less reliable than those relating to other aspects of accessibility and interaction, some degree of insight into the importance of external contact was obtained.

These seven measures of accessibility are placed alongside measures based on the topological indices calculated in the previous chapter. It was shown in the last chapter that it was possible to distinguish considerable contrasts in both the structural properties of Tamil Nadu's transport networks and in nodal accessibility to them. However, it is not possible to transfer such indices directly to the village level analysis as very few of the villages lie directly on the main routes or <u>edges</u> of the networks, and in any event do not constitute <u>vertices</u> on the networks as analysed.

Despite the problems posed by this lack of compatibality between the network measures outlined above and the analysis of village level change it is possible to apply them in slightly modified form. The procedure adopted below is to rank villages according to the accessibility scores of their nearest (i.e. most accessible) neighbour. Such scores are calculated with respect to three separate measures of accessibility which it was argued in Chapter Six are significant: accessibility to the district level network of towns, accessibility to the State level system and accessibility to the railway network. In the previous chapter major regional contrasts in the nodal accessibility patterns of towns and in the structural accessibility patterns of road and rail networks were found to exist. In the next chapter the significance of such patterns for patterns of agricultural and economic change at the village level is assessed.

The focus of this thesis is village level patterns of change and the importance of urban accessibility in this context. It still remains to ask what significance attaches to the choice of three size classes of centre. It is not suggested here that the approach adopted lends itself to an analysis of a possible hierarchy of urban services or of the spatial mechanism through which economic change is mediated. The focus is not on the towns themselves and their role as mediators of the new inputs in agriculture or of consumer goods, but on the village and the factors affecting village level patterns of adoption. Thus the choice of the three size classes is to some extent arbitrary. It cannot be inferred from this type of analysis whether or not there is a hierarchy of distribution for different order goods (Wanmali 1966,1975). The intention is simply to see whether in a general sense size of city is a factor relevant to patterns of change in villages, and if possible to identify in what elements of the village economy, if any, size of the nearest urban centre plays a part. In order to reach a full understanding of the processes by which innovations are disseminated it would be necessary to analyse the role of individual cities, their functions and linkages with each other and their hinterlands. Only then would it be possible to assess the precise nature of the " chain of command " through which the system operates. By isolating the village level base of the complete system it is inevitable that only a partial picture can be obtained. On the basis of such an analysis, however, it should prove possible to formulate more specific hypotheses relating accessibility to urban centres of different sizes, and to the more general characteristics of accessibility discussed above.

7.5. Urban Accessibility and Agricultural Change

In the first stage of the analysis of urban influence on village level patterns of change the simple correlation matrices are examined showing the correlation between the indices under examination and accessibility to urban centres of different size. In the second stage these simple correlations are tested by controlling other variables within the data set in the attempt to pick out the genuine from the spurious relationships, thereby isolating the truly significant relationships.

7.5.a Distance from towns of 20,000: Several writers have shown that small towns in India fulfill a much more limited role than their counterparts in terms of size in Europe or the United States (Johnson 1971, Breese 1972, Dupuis 1968) . Although under the classification system adopted by the Census of India 1971 all settlements over 5,000 can be classified as urban, Mitra (1965) showed that fewer than 75% of the places classified as urban in the basis of size alone in the 1961 Census qualified on the other defining characteristics, such as the proportion of the population engaged in non-agricultural pursuits. This also applied to towns of 10,000, and thus although it can be argued that in some respects towns of 10,000 are sufficiently large to be classified as urban, for this section of the analysis 20,000 has been selected as the minimum size in view of the apparent fact that it is the lowest size at which some urban functions are consistently found.

Throughout this size class of town there is generally little industrial development and retail and wholesale activity are also weakly represented. However, they are frequently the site of periodic markets if not of permanent ones, and in Tamil Nadu they are commonly the foci of bus routes. Thus they are the lowest level vertices on the State's transport system (though not necessarily of the district's) through which it is necessary to pass if contact is to be made with other parts of the system. Although manufacturing activity is only rarely found in the smaller towns of this size class, and that generally small-scale or cottage based industry, it was increasingly evident in 1971 that towns in this size group were active as centres where machinery could be repaired (Figure 7.2). Thus there is growing evidence to suggest that such towns might be expected to play a role in the life of the villages round them.

Several points of interest emerge from an examination of the correlation coefficients relating the variables of change to distance from urban centres of this size group.

1. The first set of simple correlations relate to the general characteristics of village accessibility, relating the distance of villages from the towns of 20,000 to the distance from other cities, and to the other indices of accessibility. Examination of these correlation coefficients shows that villages which are distant from the towns of 20,000 are also remote from all the other centres except those in the 100,000 class, with which there is no correlation. The highest correlation is with distance from a railway station, but it is also positively correlated with distance from the nearest city of 1,000,000 , distance from the nearest market and distance from the nearest bus stop. All these positive correlations point to the fact that villages that are remote from the smaller towns are characterised by a high degree of remoteness both to the transport system and to the largest cities. In its turn

Table 7.1 Correlations between distance from towns of 20,000 and variables of change

	DISTC	DISTD	DISTF	DISTI	NOBUS	CAMKT	FDCAG	VARI	HYVB	WLHYV	WLFERT	IRRIGW
DISTA	.3108**	.2221**	.2165**	.4931**	-.2402**	-.1832	-.2446*	-.1988	-.2223*	-.2172*	-.3284**	-.1504

**Significant at99.9%
*   "   at 99%

Notes: This table contains only those correlation coefficients at a level of significance of 95% or above. The complete correlation matrix for all variables is shown in Appendix .

Key: DISTA - Distance from towns of 20,000; DISTC - distance from towns of 1 million; DISTD - Distance from nearest market; DISTF - distance from nearest bus stop; DISTI - Distance from nearest railway station; NOBUS - number of buses per day; CAMKT - Percentage of main crop to market; FDCAG - Percentage of food crops sold to market; VARI - Number of scooters and cars; HYVB - proportion of second crop under high yielding varieties; WLHYV - Proportion of wet land under high yielding varieties; WLFERT - proportion of wet land under fertiliser; IRRIGW - proportion of land under well irrigation.

Figure 7.2.a Repair shops, Tiruppattur
North Arcot District

Figure 7.2.b

however it suggests that relationships between distance from towns of 20,000 and the variables of change under study which may be statistically significant could be spurious, and reflect merely the influence of other forms of accessibility imposing themselves on the patterns found around the 20,000 towns. This point is examined through the partial correlation analysis, in which each of the measures of accessibility is held constant in order to distinguish that part of the correlation coefficient which is the result only of distance from towns of 20,000.

2. The simple correlation coefficients are very low. Only the coefficient relating the proportion of wet land receiving fertiliser to distance from urban centres of this class is significant at the 99.9% level. The other variables of agricultural change which show a significant negative correlation with distance are the proportion of wet land under high yielding varieties of seed and the proportion of the second crop sown to high yielding varieties. The only non-agricultural variable which shows a negative correlation with distance from these towns is the proportion of the population with a scooter or car. The low level of correlation coefficients means that despite their statistical significance even the most highly correlated only accounts for under 10% of the variance - the percentage of the variance accounted for being equal to the square of the correlation coefficient. This clearly indicates the low level of explanation of the distribution of new agricultural practices explained by distance from towns of this class. Nonetheless some relationship is found, and when the range of variables is increased it is found that some others also have a negative relation with distance from towns of 20,000 - the proportion of the land irrigated by well, the percentage of the main crop that is sold to market, and the proportion of food crops

through agents.

3. If Table 7.1 shows some statistically significant correlations and potentially interesting relationships, it also shows the absence of significant correlation coefficients which are equally important with respect to the hypotheses advanced above. It is noteworthy that there is no significant correlation between distance from towns of 20,000 and the adoption of pumpsets, the number of oil stoves, radios or bicycles. This suggests that even if towns of this size class do act as centres of distribution for such important elements of changing agricultural and economic practice in the State, distance from them acts as no bar to their introduction and use.

4. In addition to the correlation coefficients between distance from towns of 20,000 and the variables of change, reference should be made back to the first finding, that of the degree of correlation between distance from towns of 20,000 and the other measures of accessibility. It may be asked whether the negative correlation between distance from towns of 20,000 and the proportion of wet land under high yielding varieties really reflects this factor or the overriding influence of distance from the 1,000,000 cities , from railway stations or from bus stops. This possibility is examined further though the partial correlation analysis.

5. Amongst the variables relating to agricultural change there are some apparently paradoxical results. Thus while the proportion of wet land with chemical fertiliser applied appears to decrease with increasing distance from towns of this size class, the proportion of farmers using chemical fertiliser shows no such relationship. Similarly, the proportion of wet land under high yielding varieties of seed and the

proportion of the second crop under high yielding varieties decline with distance, but the proportion of the main crop under high yielding varieties fails to show such a pattern. Both of these apparent anomalies are examined further through the partial correlation analysis.

6. Table 7.2 sets out the partial correlation coefficients for variables in relation to distance from towns of 20,000. Strikingly, of the variables which showed a negative correlation with distance from the towns in the simple correlation matrix only one is unaffected by controlling for the influence of other variables. The spatial control which has the greatest effect is that of distance from a railway station. When this is controlled the significant negative correlation for scooters and cars disappears, as does the correlation for the proportion of wet land under high yielding varieties. In contrast, when distance from towns of 1,000,000 is controlled a significant negative correlation between main crop high yielding varieties and distance from the towns of 20,000 comes to light for the first time. Thus while it would seem that the former relationships are spurious and are produced by the influence of the third co-varying factor of distance from a railway station, a real relationship between distance from these smaller towns and the use of high yielding varieties of seed may be being masked by the intervention of the control exercised by distance from the 1,000,000 cities.

Further analysis of the partial controls clarifies the situation. It is found that for every variable which shows a negative correlation with distance from the small towns, including those which only show a relationship when some other variable is controlled, only one relationship

Table 7.2 Partial correlation coefficients relating to distance from towns of 20,000

Control variable	Correlating variable	VARI	HYVA	HYVB	WLHYV	FFERT	WLFERT	IRRIGW
DISTB		-.1743	-	-.2080*	-.2013*	-	-.3147**	-.1569
DISTC		-.1745	-.1924	-.2201*	-.2624**	-	-.2957**	-
DISTD		-.1545	-.1478	-.2242*	-.2088*	-	-.3319**	-
DISTF		-.1637	-	-.2039*	-.1730	-	-.2930**	-.1456
DISTI		-	-	-.1756	-	-	-.2755**	-.1502
NOBUS		-.1722	-.1542	-.2237*	-.2257*	-	-.3286**	-.1501
VARE		-.1768	-.1493	-.2245*	-.2203*	-	-.3233**	-
VARF		-.1858	-	-.2085*	-.1989	-	-.3208**	-.1778
VARG		- 1587	-	-.1943	-.1908	-	-.3095**	-.1595
VARH		-.1519	-	-.2021*	-.2062*	-	-.3204**	-
VARI		x	-.1554	-.1982	-.2002	-	-.3063**	-
CAMKT		-.1907	-	-.2078*	-.1776	-	-.3082**	-.1449
WLHYV		-.1800	-	-	x	-	-.2782**	-.1716
WLFERT		-.1564	-	-.1506	-	.1442	x	-.1782
IRRIGC		-.2033*	-	-.2023*	-.1968	-	-.3174**	-.2143*
IRRIGW		-.1892	-.1688	-.2376*	-.2320*	.1590	-.3408**	x

Key: Newly introduced variable only)

HYVA % of main crop h.y.v.
FFERT % of farmers using h.y.v
VARE No. electric pumpsets
VARF No. stoves
VARG No. radios
VARH No. bicycles

remains significant irrespective of which controls are applied. This variable is the proportion of wet land to which fertiliser is applied. Thus there is a highly significant and stable negative relationship between fertiliser use on wet land and distance from the towns of 20,000. It is a stable relationship in the sense that it is unaffected by controls at the first or second order (i.e. controlling for one or two variables, together or separately). Examining the relationship between distance and other variables while controlling for the proportion of wet land under fertiliser highlights its importance. Thus the significant correlation of high yielding varieties (second crop) disappears when fertiliser use on wet land is held constant. Similarly the correlation coefficient for wet land under high yielding varieties of seed, negative and relatively high in the simple correlation matrix, disappears when distance from the railway and the proportion of wet land under fertiliser are held constant. This would suggest that the use of high yielding varieties of seed is not directly affected by distance from small towns at all, but is indirectly affected through the influence of fertiliser use. Even the controlling influence of the distance from 1,000,000 cities, which appeared to cause the relationship between distance from small towns and the proportion of the first crop under high yielding varieties to be obscured, is itself shown to be secondary in importance to that of the influence of the proportion of wet land under fertiliser. This is clear from the fact that when distance from the 1,000,000 cities and the proportion of the wet land under fertiliser are controlled together the correlation coefficient drops to .0021 - complete insignificance.

From the above analysis it would appear that the direct impact of towns in the 20,000 size group on patterns of agricultural change and consumer innovation in their immediate hinterlands is very slight. It may be argued however that in indirect terms such influence is not without importance. For despite the relatively low level of explanation obtained, it seems clear that distance from such small towns is significantly - negatively -correlated with the adoption and use of chemical fertilisers. This would appear to be true, not of the proportion of the farmers who use fertiliser but of the proportion of irrigated land which receives fertiliser applications. It is the level of such applications that then affects the extent to which high yielding varieties of seed are used. This finding, if valid, would support the contention of Hutchinson (1971) who argued that the " green revolution" in India was better interpreted as a long term process of change in which only those areas that had experienced an increase in fertiliser use would benefit.

The most interesting point to note is that the significance of the correlation between distance from smaller towns and the use of chemical fertilisers appears to be independent of any influence from the larger cities. Thus the control for both the 100,000 cities and the 1,000,000 cities scarcely reduces the strength of the coefficients at all. Furthermore, the closeness of the dependence of the proportion of wet land under high yielding varieties on fertiliser use is masked by the influence of the 1,000,000 cities. When their influence is controlled for , the negative correlation coefficient between distance from the smaller towns and the proportion of wet land under high yielding varieties rises to -.2624 , significant at the 99.9% level. The strength of the relationship however is shown to be very largely explained by the proportion of wet land having fertiliser applied, for in the second order partial, when fertiliser use and distance from 1,000,000 cities are controlled together, the relationship ceases to be statistically significant.

Thus far the analysis has focussed attention on the importance of accessibility factors and on the interacting role of the variables of change themselves. Clearly however non-spatial factors and variables not directly associated with change may also have a bearing on village level patterns of change and on the adoption of new techniques For this reason several of the other variables also need to be examined. It is noteworthy that none of the so-called " non-spatial " variables reduces the correlation coefficient for the proportion of wet land having fertiliser applied. This is true for variables which may be taken to reflect in some measure the social structure of the village (proportion of scheduled castes), the economic structure of the village (percentage of tenants) or the demographic structure of the village (population growth rates). Equally interesting is the fact that literacy does not have any impact on the level of the coefficient, which suggests that the spatial pattern of adoption and use of chemical fertiliser is not affected strongly by educational levels. Although this contention is examined more thoroughly below, it is clear that none of these factors affect the significance of the correlation coefficient between distance from small towns and fertiliser use on wet land.

The only non-spatial variable which affects the correlation coefficient noticeably is the proportion of land under well irrigation. Itself negatively correlated with distance from small towns, its control pushes up the partial correlation between distance from small towns and the proportion of wet land with chemical fertiliser to -.3408. It also allows two other variables to show a significant correlation with distance from the small urban centres - the proportion of land irrigated by canal and the percentage of farmers using fertiliser. Both are only just significant at the 95% level. In the former case there is no reason to suspect a causative relationship between the distance from a small town and the proportion of land that is irrigated by canal. It may therefore be suspected that this is a spurious relationship . The latter case may be accounted for by the fact that villages with a relatively high proportion of well irrigation have a low percentage of farmers using fertiliser. As distance increases so the proportion of land under well irrigation decreases. As this proportion decreases so the proportion of farmers using fertiliser increases. Only by holding the well irrigation constant is it possible to isolate the effect of distance from that of well irrigation, and for it to be shown that if the influence of well irrigation is discounted there is a relationship, albeit a weak one, between distance from the small towns and the proportion of farmers using fertiliser.

The overriding conclusion from the foregoing analysis must be that in many respects distance from towns in the size group 20,000 to 100,000 plays at most a minor role both in agricultural change and in consumer innovation. Not only are few of the variables consistently correlated with distance from small towns but even the significant correlation coefficients remain low.

explaining no more than 10% of the variance. Only one of the important innovations to have affected agriculture in Tamil Nadu by 1971 showed the direct effect of distance, that of fertiliser use, and although the indirect implications of this have been shown to be of some importance the general conclusion remains valid.

7.5.b Distance from Towns of 100,000 to 1,000,000

The fifteen towns which came into the category 100,000 to 1,000,000 in 1971 varied considerably in their economic and social characteristics. However, despite the inevitable blurring at the margins of the group they are in general far more complex than the smaller centres and they fulfil a far greater range of functions. Towns such as Madurai, Coimbatore and Tiruchirappalli have a well developed industrial base, both of large-scale and small-scale industry. They have highly developed retail functions (in terms of the normal pattern in Tamil Nadu) and many also have important administrative roles. Thus they are both qualitatively more complex as well as quantitatively larger than the towns of the smaller size class Part of this complexity and part of the increased functional range is undoubtedly " self-serving " , or non-basic to use the terminology of Alexander (1954). Although they are the only centres in which some purchases can be made, this fact does not necessarily imply that large numbers of people travel from outside towns to make purchases. However, bicycles, radios, cooking stoves, paraffin lights, scooters as well as a large range of agricultural equipment such as electric pumpsets, are all far more readily available in these centres than outside them. Thus it may be expected that if contact

Figure 7.4 Distance to towns of 100,000 in Tamil Nadu

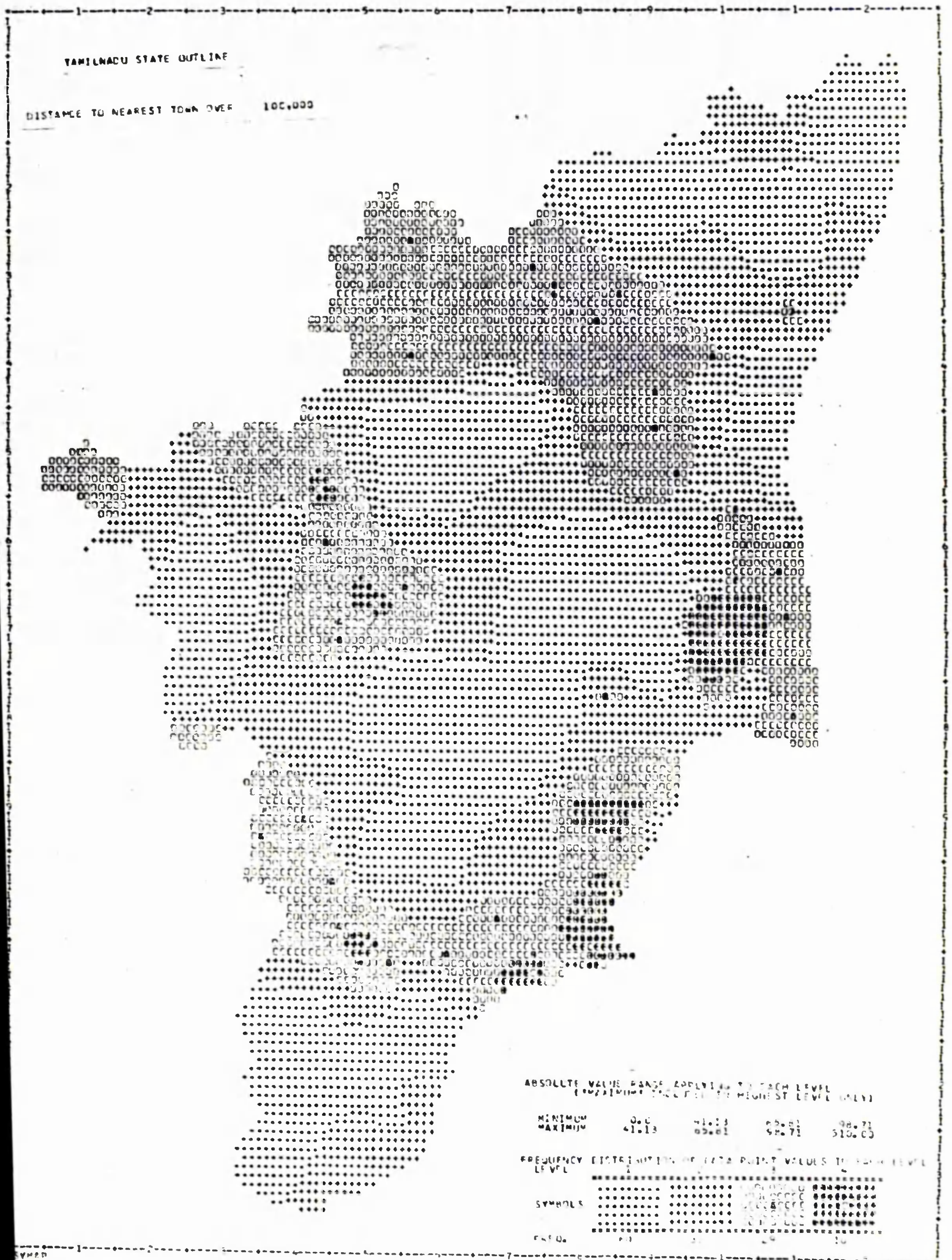


Table 7.3 Correlation between distance from towns of 100,000 and variables of change

	DISTC	DISTI	NOBUS	VARB	VARF	VARG	VARH	VARI	HYVB	WLHYV	FFERT	WLFERT
DISTB	.2445*	.2886**	-.1733*	-.2191*	-.1546	-.1529	-.1945	-.2684**	-.1514	-.1686	-.2540*	-.1723

	WLFERT	PERSCM	PERSCF	PERLM	PERLF	PERWM	PERLAM
DISTB		-.1593	-.1495	-.2421*	-.1904	-.2368*	-.2195*

* Significant at 99%
** Significant at 99.9%

VARB - Number of travellers per day; PERSCM - percentage of the population scheduled castes, male; PERSCF - percentage of the population scheduled castes, female; PERLM - percentage of the male population literate; PERLF - percentage of the female population literate; PERWM - percentage of the male population classified as workers; PERLAM - percentage of the male population classified as agricultural labourers.

with such centres is an important part in the extent to which villagers receive innovations of this kind, then it may be predicted that distance from such towns will have a negative effect on their adoption.

Table 7.3 sets out the simple correlations between distance from the 100,000 cities and the adoption of new agricultural practices and consumer goods As was found to be the case with village location patterns relative to the smaller centres, so at this level it is found that villages that are accessible to the cities of 100,000 tend also to be accessible to other large cities and to railway stations. The correlation between distance from the 100,000 cities and distance from a railway station is considerably weaker than that for the smaller cities (.2886 as against .4931) , a reflection of the fact that there is a wide distribution of railway stations outside the larger cities while there are relatively few stations outside the smaller towns. This lower correlation between access to the city and access to the railway station means that it is possible to distinguish their relative importance more clearly, and the role of rail transport in economic and agricultural change is thus of considerable interest.

It can be seen from the simple correlation matrix (Table 7.3)that there is a larger number of significant correlations relating to the 100,000 cities than to the smaller towns. The most interesting points are :

1. All of the consumer variables have a statistically significant relationship with distance from the 100,000 cities. The proportion of the village population owning stoves, radios, bicycles , scooters and cars all decreases as distance from the 100,000 cities increases. In addition the variables relating to agricultural change also show negative correlations. The

proportion of the second crop sown to high yielding varieties of seed, the percentage of farmers using chemical fertiliser and the proportion of wet land having fertiliser applied all share this characteristic negative relationship. At first sight it would appear that the cities of 100,000 have an important role in the spatial organisation of change in their hinterlands, not only in agriculture but in the wider economic sphere as well. Only two of the variables of change under discussion - adoption of pumpsets and the proportion of the first crop under high yielding varieties - show no such simple negative relationship.

2. In addition to the variables relating to agricultural and economic change, several other variables on the demographic side also show a negative correlation with distance from the 100,000 cities. The proportion of the population made up of scheduled castes, the proportion of literates, the proportion of males working in the population and the proportion of male labourers all have negative correlations significant at the 99% level or above.

3. As was found to be the case with the correlation coefficients relating to distance from smaller towns, the level of explanation achieved is very low despite the statistical significance of the results. The highest correlation coefficient is -.2684 (scooters and cars), that is less than 5% of the variance is explained. The highest level of explanation for the agricultural variables is that relating to the proportion of farmers using fertiliser (-.2540). Again the proportion of the variance explained is less than 5%.

4. The simple correlation coefficients suggest a contrast between the influence of the smaller

towns and that of the 100,000 cities. The most striking difference lies in the relative strength of the correlations for the proportions of farmers using fertiliser and the proportion of wet land having fertiliser applied. It will be recalled that around the smaller towns it was the latter variable that showed the most significant and stable relationship, in the sense of being unaffected by control variables. Round the 100,000 cities the pattern is reversed. Clearly these two variables are themselves closely related (r = +.6271), though not by any means identical. The difference between the two town size groups could be explained by the hypothesis that the small towns are significant as the last link in the physical distribution system of fertilisers. The cost of distance from these smaller towns is borne directly by the farmer, both in terms of time and money, as there is no effective farm-gate distribution service or equal farm-gate price. In contrast, distance from the larger cities has little direct effect on price of fertilisers. However, the proportion of farmers using fertilisers reflects not only the costs of the input but also willingness, knowledge and ability to use it. This in turn may reflect the farmer's credit facilities as well as his access to information. It is the proportion of farmers using fertiliser which is found to have a strong negative correlation with distance from the 100,000 cities, which could be taken as lending some support to this view. The explanation itself however remains a simplistic one, and without further detailed analysis of the spatial organisation of the supposedly influential factors such as credit availability and the relevance of information flows, must remain speculative rather than a firm conclusion. It can be noted however that the correlation between distance from the 100,000 cities and the proportion of farmers

First order partial correlation coefficients

Control variable	VARB	VARF	VARG	VARH	VARI	HYVB	WLHYV	FFERT	WLFERT	PERLM	PERLF
DISTA	-.2060*	-.1432	-	-.1813	-.2514*	-	-.1472	-.2452*	-.1419	-.2308*	-.1817
DISTC	-.2016*	-	-	-.1681	-.2507*	-.1455	-.2000	-.2616**	-	-.2556*	-.2242*
DISTD	-.2164	-.1532	-.1497	-.1920	-.2678**	-.1509	-.1669	-.2545*	-.1717	-.2414*	-.1885
DISTF	-.2046	-	-	-.1711	-.2505*	-.1738	-.1827	-.2600**	-.2034	-.2231*	-.1662
DISTI	-.1756	-	-	-	-.2329*	-	-	-.2304	-	-.1710	-
ACCDIST	-.2256	-.1706	-.1626	-.2110	-.2706*	-.1738	-.1827	-.2600**	-.2034*	-.2417*	-.2027*
NOBUS	-.1701	-	-	-.1766	-.2506*	-.1500	-.1726	-.2362*	-.1680	-.2382*	-.1998
VARB	x	-	-	-.1464	-.2081*	-.1506	-.1534	-.2390*	-.1551	-.2610*	-.1991
VARE	-.2061*	-.1572	-	-.1703	-.2378*	-.1544	-.1732	-.2476*	-.1636	-.2379*	-.1767
VARG	-.2051*	-	x	-.1509	-.2297	-	-	-.2292*	-.1462	-.2222*	-.1504
VARH	-.1782	-	-	x	-.1999	-	-.1519	-.2579**	-.1584	-.1987	-
VARI	-.1360	-	-	-	x	-	-.1449	-.2487*	-	-.2108	-
HYVB	-.2185*	-	-	-.1708	-.2512*	x	-	-.2332*	-	-.2144*	-.1584
WLHYV	-.2078*	-	-	-.1803	-.2548*	-	x	- 2337*	-	-.2172*	-.1543
WLFERT	-.2062*	-	-	-.1825	-.2475*	-	-	-.1903	x	-.2259*	-.1712
IRRIGC	-.2192*	-	-.1441	-.1901	-.2723**	-	-.1501	-.2424*	-.1604	-.2312*	-.1768
IRRIGW	-.2204	-.1491	-.1510	-.2060	-.2732**	-.1486	-.1660	-.2544*	-.1704	-.2397*	-.1856
PERLM	-.2400*	-	-	-	-.2410	-	-	-.2346*	-.1479	x	-
PERLF	-.2197*	-	-	-	-.2322*	-	-	-.2253*	-.1507	- 1526	x

(Continued)

Second order partial correlation coefficients

Control variables	VARB	VARF	VARG	VARH	VARI	HYVB	WLHYV	FFERT	WLFERT	PERLM	PERLF
DISTA + DISTC	-.1977	-	-	-.1644	-.2465*	-	-.1947	-.2585**	-	-.2518*	-.2202*
DISTA + DISTD	-.2068*	-.1430	-	-.1842	-.2548*	-	-.1471	-.2457*	-	-.2308*	-.1815
DISTA + DISTF	-.1962	-	-	-.1640	-.2393*	-	-	-.2374*	-	-.2169*	-.1638
DISTA + DISTI	-.1774	-	-	-	-.2388*	-	-	-.2319*	-	-.1703	-
DISTA + NOBUS	-.1644	-	-	-.1693	-.2409*	-	-.1588	-.2320	-.1501	-.2311*	-.1931
DISTA + ACCDIST	-.2125*	-.1593	-.1482	-.1980	-.2532*	-.1515	-.1613	-.2512*	-.1738	-.2301*	-.1941

* Significant at the 99% level
** Significant at the 99.9% level

The codes used in this Table are identical with those used in Tables 7.1, 7.2, and 7.3. The key is found with those Tables. This Table is not a complete summary of the partial correlation coefficients, but represents the basic pattern. Further specific figures are referred to in the text.

using fertiliser remains significant even when the proportion of wet land receiving fertiliser is held constant, and it is the only agricultural variable to retain this relationship.

5. The partial correlation coefficients make it clear that the greater apparent influence of the 100,000 cities has to be interpreted with considerable caution. The pattern of relationship between distance and the distribution of agricultural variables other than the proportion of farmers using fertiliser becomes complex when partial controls are applied. All the significant correlations disappear when one or other of the variables is held constant. Thus for example the significant correlation between the proportion of wet land receiving fertiliser applications and distance from the 100,000 cities disappears when other variables such as distance from the 1,000,000 cities , distance from a railway station, the number of cars and scooters, the proportion of the second crop under high yielding varieties or the proportion of wet land under high yielding varieties is held constant. Similarly the significant relationship between distance and the proportion of wet land under high yielding varieties disappears when distance from a bus stop, distance from a railway station, the number of radios, the proportion of the second crop sown to high yielding varieties,

the proportion of wet land receiving fertiliser applications or the percentage of literates are controlled for.

6. It might be inferred from the first order partial correlations that the simple correlations are nearly all spurious and simply the result of the influence of outside factors, diverse in their origins perhaps but all belying the

possible role of the 100,000 cities in influencing the form of the spatial patterns of change in agriculture. Such a judgment is seen to be premature when the second order partials are considered. A clue to the possible importance of the second order partials is provided by the fact that all the variables discussed above show higher negative correlations with distance from the 100,000 cities when accessibility to the district network is the partial control variable. All these partials are found to be higher than the simple correlations, not by a great deal but sufficiently to suggest that the influence of this variable may be masking the true strength of the negative relationship between distance and adoption rates of these other agricultural variables. This is shown to be the case when the second order partials in which accessibility to the district transport network is one of the two partials being controlled. In every case in which the first order partials removed the significance of the correlation, the second order saw that significance re-established. Thus high levels of accessibility to the district networks can be seen to reduce the tendency for agricultural innovation to decrease with increasing distance from the cities of 100,000 and above. The striking point lies in the distinction that it is possible to draw between distance from the towns of 20,000 and the measure of district accessibility. When the former is controlled there is little noticeable effect on the correlation coefficients, and thus it would appear that accessibility to the district network is measuring a quite distinct phenomenon, even though it is related to accessibility to towns within this size class

7. From the second order partial correlation coefficients it can be argued that several of the variables of agricultural change retain statistical significance. As was found to be the case at the lower level of the urban hierarchy, however, this relationship is both weak and , in most cases, indirect. The apparent links by which the influence of distance are mediated would also appear to have a slightly different relative importance. Most significant, and negatively correlated with distance from the 100,000 cities through all controls, is the proportion of farmers using chemical fertiliser. This is seen to control the pattern of fertiliser use on wet land, which in turn affects the proportion of wet land under high yielding varieties of seed. This is reflected again in the proportion of first and second crops sown to high yielding varieties. As was found to be the case around towns of smaller size, the overall effect of distance, though significant appears to be slight. The major impact on agricultural variables again appears to be exerted through the adoption and use of chemical fertilisers.

8. When the consumer variables are examined it is found that the strongest and most consistent correlations relate to scooters and cars. It must be borne in mind that in absolute terms these are found in tiny numbers in any village. Thus although it is not surprising that the proportion of the population with scooters or cars declines as distance from the larger cities increases , its importance as a control variable over other consumer variables suggests that it may be acting as a surrogate variable , reflecting the importance of other variables not measured in the data set.

9. The partial correlation coefficients at the first order suggest that several of the simple correlations may be spurious. The most consistent relationship is that for bicycles. The significance of this correlation disappears however when distance from a railway station is held sonstant, and also when the number of scooters or the number of literates is held constant. It is again found that accessibility to the district network plays a masking role in the relationship, and many of the correlations regain their significance when accessibility to the district is one of the control variables in the second order. The most notable relationship found through the partial correlation analysis but not evident from the simple correlation matrix is that between the number of electric pumpsets and distance from the 100,000 cities. The negative correlation between distance from these cities and the use of electric pumpsets was masked by the counter-effect of the proportion of land under canal irrigation, and to an even greater extent by the proportion of land under well irrigation. When these two variables are held constant, the pattern of adoption of pumpsets is shown to be significantly negatively correlated with distance from the 100,000 cities.

10. A further point which highlights the importance of the cities of this size range lies in the pattern of movement from the villages. It is found that as distance from cities of this size class increases so the number of daily travellers decreases. This does not necessarily reflect the fact that direct movement to the cities of 100,000 and above tails off as distance from them increases, though a considerable amount of such daily commuting does take place from villages near to the cities. However, it

does support the contention advanced earlier in this Chapter that villages remote from small towns are also characterised by remoteness on a range of other indices. Around the cities of 100,000 increasing remoteness is characterised by decreasing external contact between the village and other centres. This remoteness and low level of external contact can itself be seen as a factor in the process of spatial organisation of change, as it reduces the partial correlation between distance from the 100,000 cities and the number of stoves and radios to insignificance.

11. One other point of interest arises from both the simple and the partial correlation matrices. From both it can be seen that the proportion of male and female literates shows a strong negative correlation with distance from the cities of 100,000 and 1,000,0000. The percentage of male literates in the village population shows a negative correlation coefficient of -.2421, that of the female literates being -.1904. None of the partial controls reduce the significance of these correlations at either the first or the second order of controls. It can thus be concluded that this forms a significant feature of the demographic structure of the urban hinterlands. It is of course well known that literacy is far higher within the urban areas than in rural ones. These correlation coefficients suggest that accessibility to cities in the size range 100,000 and above is an important factor in the extent to which village populations are literate, which does not apply to the smaller centres. It is not the object of this thesis to examine the spatial structure of demographic indices in their own right, but only insofar as they influence patterns of change in village life. The systematic orientation of literacy to the larger urban

centres at least suggests the possibility that it may be a control variable of some importance. This is examined further below.

12. It can be concluded that despite the low level of explanation of the variance in the data several variables do display a negative correlation with distance from the cities in the size range 100,000 to 1,000,000. The partial correlation analysis has highlighted the complexity of the interrelation of the the variables, as well as clarifying some of the basic relationships that exist between distance from the urban centres and spatial patterns of adoption both of new consumer goods and of new agricultural technology. Thus despite the impression that spatial factors play only a minor role at this level there can be no doubt that distance from cities of this size is one of the factors at work.

7.5.c Distance from Cities of 1,000,000: The two cities of 1.000.000 and above contrast in many important respects with the cities of 100,000 to 1,000,000. Madras, the most important of them not only in terms of size but also in terms of its economic and administrative significance, had a population of 2.4 million in 1971, five times that of the next largest city within Tamil Nadu By far the most important port in the State, the focus of the inter-State road and rail network, it was also the seat of the State's Government. It had the commercial headquarters of many of the most important industrial enterprises. It was also the site of the most rapid industrial expansion growth having occurred in the twenty-five years since Independence on a scale unparallelled in southern India. Bangalore, with a population in 1971 of 1.3 million was also a rapidly growing industrial cente, particularly for some large Government concerns in the aeronautical and telecommunications industries. Its importance for Tamil Nadu was very much slighter than that of Madras, for not only is it in the neighbouring State of Karnataka but in 1971 it had far fewer economic links with Tamil Nadu than did Madras. Only a relatively small area of north-western Tamil Nadu in Dharmapuri and North Arcot Districts lies within the effective orbit of Bangalore. Thus for the majority of the sample villages studied it was distance from Madras that was under examination as a factor in the spatial organisation of change.

1. Table 7.5 shows the simple correlations between distance from the 1,000,000 cities and the variables of change. There are striking contrasts betwen those variables which show significant correlations with distance from the 1,000,000 cities and those which are correlated with distance from the smaller central cities. Negative correlations are found for the variables electric pumpsets, stoves and radios. However the only variable relating to agricultural change which shows any correlation with distance from the 1,000,000 cities—is the proportion of wet land with fertiliser applied to it.

2. In addition to these significant correlations six others show orientation to the 1,000,000 cities; the proportion of land under well irrigation, the proportion of food crops sold to agents, the percentage of farmers who are tenants, the percentage of land under paddy, the percentage of scheduled castes and the percentage of the female population at work.

3. The clearest feature is the absence of any significant relationship for most of the

Table 7.5 Correlations between distance from towns of 1,000,000 and variables of change

	DISTA	DISTB	DISTI	NOBUS	VARE	VARF	VARG	VARN	WLFERT	IRRIGW	PERTEN
DISTC	.3108**	.2445*	.2806*	-.3174**	-.2497*	-.2335*	-.1880	-.1623	-.1645	-.2195*	-.2398

	PERPAD	PERSCM	PERSCF
DISTC	-.2582**	-.2357*	-.2274*

VARN - population growth 1961-1971; PERTEN - percentage of farmers who are tenants; PERPAD - percentage of the cultivated land under paddy cultivation; PERSCM - percentage of the population (male) belonging to the scheduled castes; PERSCF - percentage of the population (female) belonging to the scheduled castes.

agricultural variables for which distance from the smaller towns proved to be of some importance. This lack of a relationship shown by many of the simple correlation coefficients applies also to the availability of scooters and bicycles, over which the 100,000 cities were shown to have some influence. Of all the variables studied the simple correlation coefficients suggest that only two consumer variables are related to distance from the 1,000,000 cities.

4. In addition to the negative correlation coefficients there is a group of positive correlations. These are largely related to the other measures of accessibility, and broadly confirm the patterns of remoteness discussed above. Thus it is found that villages remote from the 1,000,000 cities tend also to be relatively distant from both groups and smaller towns, as well as from bus stops and railway stations. In other words the picture of villages grouped according to their relative accessibility to urban centres receives further support from the simple correlations at this level.

5. The final point that must be made concerning the simple correlation coefficients relates to their very low level of explanation of the variance in the data . The highest level of explained variance is as little as 8% and for most of the variables for which there is a statistically significant relationship the figure is below 5%. Thus distance from the largest cities is no better an explanation in statistical terms of the spatial patterns of distribution of the variables under study than the two other size classes of city.

6. The partial correlation coefficients again illustrate the importance of not taking the simple correlation coefficients at face value. However, the effect of the first order controls is rather different from that seen previously. Generally more of the correlations which were significant in the simple correlation table hold good despite the controls. On the other hand the introduction of controls allows several new correlations to emerge. Control of the variables relating to the availability of pumpsets fails to remove their significance, and the relationship between the use of electric pumpsets and distance from cities of 1,000,000 remains significant irrespective of such a crucial co-varying control as proportion of land under well irrigation.

7. Similarly the village-wise adoption of stoves shows an unbroken pattern of negative correlation with distance from the largest metropolitan centres. While a few of the control variables account for some of the variance in the relationship others improve it markedly. Thus while controlling for the percentage of households with radios reduces the coefficient from -.2335 to -.173, controlling for well irrigation increases it to -.2910. The pattern of distribution of radio sets is a little more equivocal, as the significance of the correlation is removed by three control variables - distance from a railway, pumpsets per acre and number of stoves.

8. The variables of agricultural change, much less weakly related to distance from the 1,000,000 cities than to distance from the smaller towns and cities, show complex orientation to the metropolitan centres when the partial correlation tables are examined. In the simple correlation matrix wet land under fertiliser was the only variable related to

Table 7.6 Partial correlation coefficients relating to cities of 1,000,000

First order partial correlation coefficients

Control variable	VARC	VARD	VARE	VARF	VARG	VARH	HYVA	WLHYV	WLFERT	IRRIGW
DISTA	-.1816	- 1804	- 2313*	- 2105*	-.1536	-	.1816	.1802	-	-.1838
DISTB	-.1660	- 1718	-.2244*	-.2043*	-.1571	-	.1618	.1474	-	-.2375*
DISTF	- 1936	-.1495	- 2656**	-.2503*	-.2171*	-.1662	-	-	-.1966	-.2253*
DISTI	-.1481	- 1946	- 2129*	-.1808	-	-	1650	.1635	-	-.2171*
ACCDIST	- 1859	-.1706	-.2621**	-.2173	-.1777	-	-	.2020	-	-.2339*
ACCLAKH	-.1818	-.1554	-.2499	-.2348	-.1887	-	-	-	-.1648	-.2207*
ACCRL	-	-.1441	-.2054*	-.2316*	-.2447*	-	-	-	-.1485	-.2026*
NOBUS	-.1739	-.2010	-.2127*	-.1928	-.1688	-	-	-	-.1602	-.2249*
VARE	-	-	x	-.2430*	-	-	-	-	-.1505	-.1488
VARF	-.1833	-.1729	-.2585**	x	-	-	.1878	.1583	- 1459	-.2802**
VARG	-	-.1627	-.2314*	-.1783	x	-	.1840	.1527	-	-.2338*
VARH	-.1646	-.1480	-.2283*	-.2225*	-.1505	-	-	-	-.1544	-.2001
FCRAG	-.1778	-.1557	-.2256*	-.2034	-.1981	-.1708	.1828	-	-	-.2310*
WLHYV	-.1742	-.1453	- 2490*	-.2627**	-.2199*	-.1470	-	-	-.2106*	- 2135*
WLFERT	-.1643	-.1636	-.2410*	-.2212*	-.1602	-	.1850	.1660	x	-.2318*
IRRIGC	-.1999	-.1585	-.2607**	-.2318*	-.1853	-	-	-	-.1612	-.2606**
IRRIGW	-	-	-.1916	-.2910**	-.2047*	-	-	-	-.1810	x
PERLITM	-.1808	-.1549	-.2512*	-.2405*	-.1946	-	-	-	-.1687	-.2184*

FCRAG - Percentage of food crops sold to markets through agents.
Relevant second and third order partials are discussed in the text.

distance. This significant relationship is shown by the partial correlation analysis to be conditioned by a number of other variables. Distance from both classes of smaller towns, distance from the railway station and accessibility to the district transport system all reduce the simple correlation to insignificance. On the other hand by controlling for the proportion of wet land under high yielding varieties the correlation coefficient is increased to -.2106, suggesting that after all the relationship might be significant. It is necessary thereforeto pursue the analysis to the third order and to control for wet land under high yielding varieties at the same time as controlling for the variables which reduce the coefficient to insignificance. When this is done it is found that the relationship does not retain its significance and must therefore be regarded as spurious. Thus it can be concluded that there is no influence exerted by the 1,000,000 cities in the use by villages of fertiliser.

9. While the partial correlation analysis showed the relationship between wet land under fertiliser and distance from the 100,000 cities to be spurious, it also suggests that some other agricultural variables may be related to distance despite the lack of a simple correlation between them. This is the first instance however of a positive relationship, for when distance from the smallest towns is controlled there is a coefficient of +.1802 for the proportion of wet land under high yielding varieties. Other controls also allow significant relationships to emerge. Distance from towns of 100,000, distance from railway stations, the distribution of radios and stoves and the proporion of wet land under fertiliser all apparently mask a

significant relationship.

Moving to the second order partials the significance is shown to increase again. When distance from small towns and district accessibility are held constant together the correlation coefficient rises to+.2020. Holding distance from small and intermediate sized towns and cities constant a further rise in the coefficient to +.2202 is registered. At the third order the significance level increases again, so that when accessibility to the district network, distance to small towns and distance to intermediate towns are all held constant together the coefficient rises to +.2507. Furthermore , whenever the distance to small towns is held constant all the correlation coefficients are significant. From this it is clear that the true pattern of adoption of high yielding varieties of seed on wet land relative to the metropolitan cities is of an increase with increasing distance from the metropolitan centre.

This pattern is confirmed by that found for the use of high yielding varieties as the main crop. This variable also shows positive correlations when the same controls are applied, adding to the strength of the link between distance from the 1,000,000 cities and high yielding variety use. The crucial variable which hides this relationship in the simple correlation matrix is distance from towns of 20,000, which were shown above to play a part in the pattern of use of such seeds, particularly on wet land.

10. The other variable which shows a negative correlation with distance from the largest cities is that of the proportion of land under well irrigation. Significant as a simple correlation, well irrigation remains significantly correlated

with distance despite all controls However, when controlled for the number of pumpsets per unit of land the correlation drops to only -.1488, barely significant at the 95% level. On the other hand when controlled by canal irrigation the coefficient rises to -.2606, significant at the 99% level. Second order partials show that where the number of pumpsets per unit of land is controlled as one of the two control variables the significance of the coefficient is lowered considerably but remains significant.

The striking feature of the relative patterns of distribution of well irrigation on the one hand and the proportion of the first crop under high yielding varieties on the other is that one is positive while the other is negative. This would suggest that there is little correlation between well irrigation and the use of high yielding varieties. This finding receives support from the correlation coefficients between the different forms of irrigation and the use of high yielding varieties. The proportion of wet land under high yielding varieties is positively correlated with the percentage of the wet land under canal irrigation ($r = +.4067$). There is no significant correlation between percentage of wet land under high yielding varieties and well irrigation and there is a negative correlation between the proportion of land under high yielding varieties and the use of tank irrigation. These relationships may partly be accounted for by the definition of wet land, which largely embraces canal irrigated land rather than tank or well irrigated land However, when the coefficients of correlation between first crop under high yielding varieties and the different forms of irrigation are examined a similar pattern emerges. Canal irrigated land is positively correlated with the proportion of the main crop under high yielding varieties - +.4798. Both well and tank irrigation are negatively correlated with the proportion of the main crop under high yielding varieties: -.1524 and -.1873 respectively. This represents further support for the argument put forward in Chapter Four that the adoption of high yielding varieties was strongly influenced by the reliablity of the irrigation source. In so far as the spatial organisation of adoption is concerned it has been shown that while well irrigation is negatively related to distance from the metropolitan cities, use of high yielding varieties increases.

Why should this relationship hold? Clearly it would be unreasonable to expect particular advantages to accrue to villages in terms of their ability or willingness to use high yielding varieties of seed as distance from Madras and Bangalore increases. It is far more likely that the explanation lies in the peripheral location of these cities relative to the areas of major canal irrigation and consequently of greatest effort in terms of agricultural development. It could be argued that the statistical significance of the relationship between distance and high yielding varieties of seed is to some degree fortuitous, a result not of the costs of distance or the benefits of the rural areas but of a regional policy in which environmental factors played the major role.

11. The correlation coefficients relating distance from the 1,000,000 cities to the variables of change are no higher than those relating to the other size groups of city. Despite this low level of explanation there is

evidence to suggest that some form of spatial patterning and organisation relative to the metropolitan centres exists. This is true of more sophisticated consumer goods such as cooking stoves and radios, and is absent for most forms of agricultural change.

7.6 Conclusion

An attempt has been made in the Chapter to trace the nature and extent of the influence of urban centres over the patterns of adoption of agricultural and consumer innovations. The results may be summarised as follows:

1. The distribution of villages has shown that those villages which are remote on one index of accessibility tend to be remote on the other indices. Villages that are distant from small towns are also distant from the large cities and from transport routes. At the village level the effects of inaccessibility may be expected to re-inforce themselves.

2. The influence of distance from cities and towns of the groups analysed has been shown to be relatively slight. The level of explained variance is consistently low, never rising to more than 20% of the variance in the data.

3. Despite the low level of explanation some of the variables have been shown to be distributed with clear reference to distance from towns and cities. However, not all the variables analysed show the same form of relationship with distance. In general the variables of agricultural change have been more clearly affected by distance from the smaller towns while the distribution of consumer goods has shown the influence of larger cities to a far greater degree.

4. The effect of non-spatial controls on the spatial patterns of innovation has been shown generally to be very slight or non-existent.

Although literacy was found to be significantly correlated with distance from cities in the 100,000 to 1,000,000 size group, this had no bearing on the spatial distribution of the other variables. Partial correlation analysis has also shown that the influence of demographic caste and occupational factors has little bearing on such spatial organisation.

5. The partial correlation analysis has suggested the possibility that environmental controls may play an important part in the spatial patterns of agricultural innovation, and that such controls can affect the importance of distance from urban centres as a factor in such innovation. However, the question of the role of such factors is subjected to more detailed analysis in the next Chapter.

6. The findings of the present Chapter have led to the conclusion that other elements of accessibility also play some part in the spatial organisation of innovation in both agricultural and non-agricultural spheres. As controls in the partial correlation analysis, both the structural measures of accessibility and the measures of distance from railway stations and bus stops have been shown to affect the significance of the correlation coefficients. In the next Chapter the role of these components of accessibility is analysed further.

CHAPTER EIGHT

Accessibility and Innovation: Secondary Measures of Accessibility

8.1 Introduction

In the last Chapter an analysis was made of the spatial impact of urban centres on the distribution of innovations which have both characterised and been responsible for changes in village life. " Shortest-route " distance was the measure of accessibility used , and in this Chapter the importance of accessibility is examined further by the analysis of alternative measures of accessibility and their bearing on innovation.

a) Distance to market. Shandies - the Tamil word for weekly markets - are widespread throughout Tamil Nadu. However, they are extremely variable in their size and functional complexity, and correspondingly variable in their regional importance. Some are specialist markets, selling for example only vegetables or other agricultural products. Equally, some draw people from considerable distances both as buyers and sellers while others are of only very minor and local importance. This variability embraces other important characteristics such as the population size of the places in which the markets are held. Some weekly markets are held in large villages or even small towns, while others may be in tiny hamlets which have no other central place functions. To treat the shandies as if they possessed uniform characteristics and as though theywere of equal potential regional significance clearly introduces an element of unreality into the analysis . Despite this shortcoming, there

Figure 8.1 Distance to most used shandy

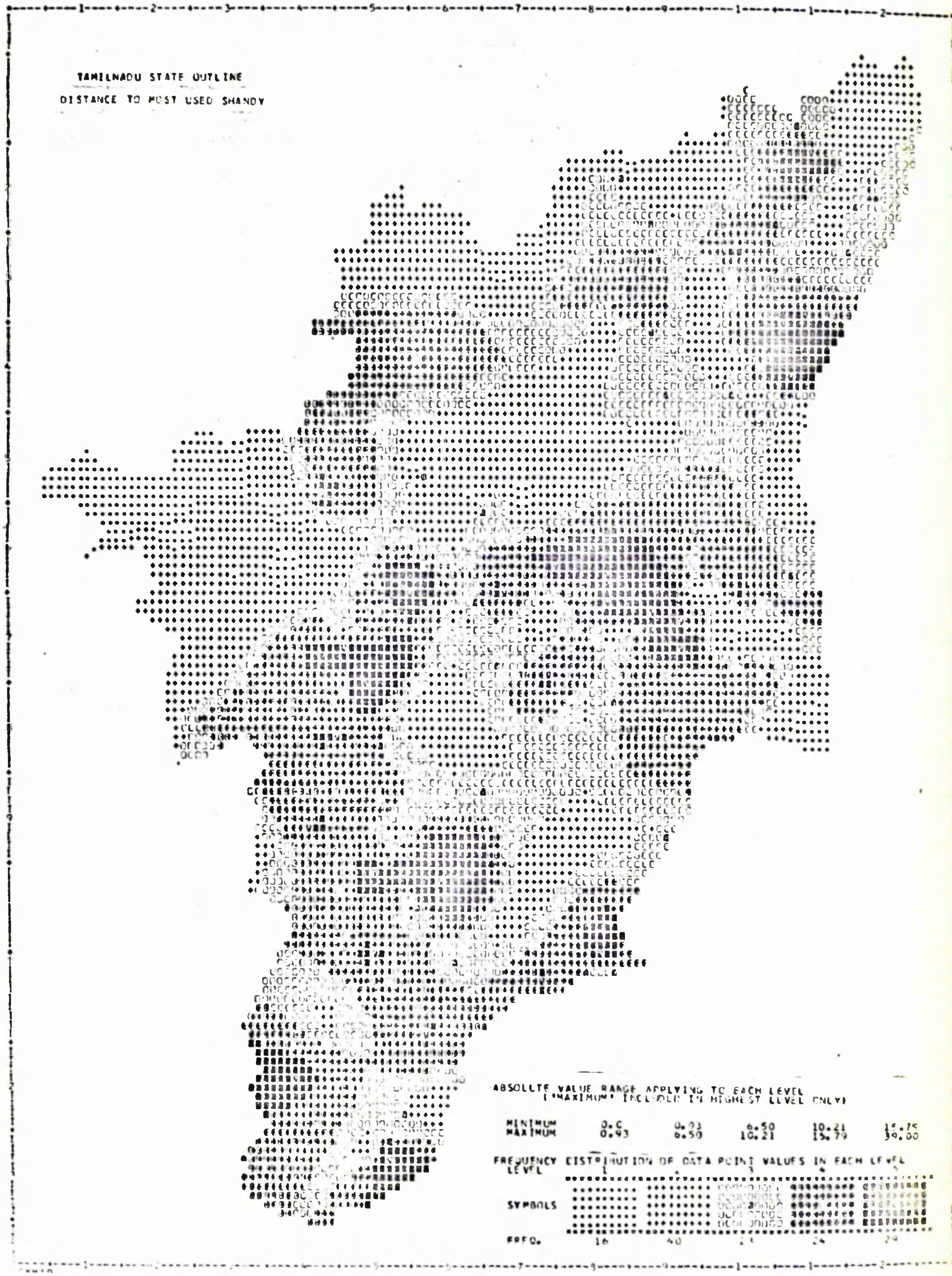
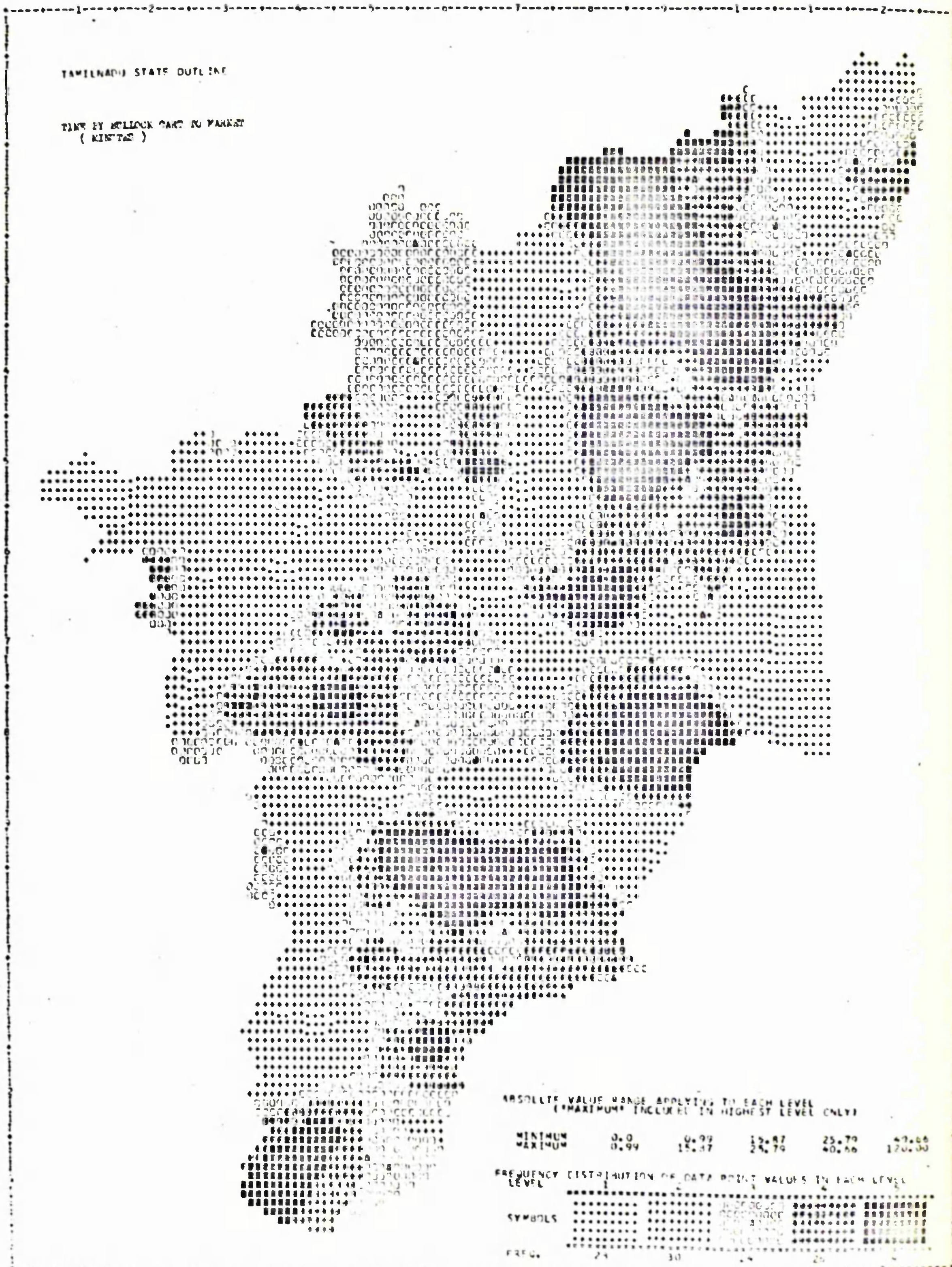


Figure 8.2 Time by bullock cart to shandy



is no doubt that the weekly markets do play some part in village life, both in social and in economic terms (Harriss 1974). It thus seems appropriate to attempt to assess whether or not such markets exert an identifiable influence over spatial patterns of adoption and innovation. Harriss (1973) has demonstrated the widespread significance of _mandies_ (wholesale markets) in both the Panjab and in Tamil Nadu, and although the scale on which most _mandies_ work is naturally greater and more complex than that of the _shandies_, the _shandy_ represents the only direct contact many villagers have with the outside world. The extent to which they were acting as mediators of change by 1971 is therefore of considerable interest.

b) Nearest bus stop. As was shown in Chapter Six the bus network in Tamil Nadu has expanded very rapidly since 1947. By 1971 few villages were more than five miles from the nearest bus stop. Along with the introduction of lorry transport buses have had a dramatice effect on the economy and social life of many villages. The bus system represents the lowest rung on the formal transport system, for inevitably bus routes focus on urban centres, however small such centres may be. Access to a bus stop therefore carries with it access to urban life. What is at issue however is not the extent to which urban contact is a factor in change but whether bus transport _per se_ can be seen as such a factor. This represents the analysis of the importance of transport at the micro-level. While in western countries the question would have no relevance because of the widespread availability of other means of transport, in the Indian economy bus stops represent the lowest level break-of-bulk point, from which the friction of distance becomes much more keenly felt, for the only means of transport beyond the bus stop is the bullock cart, bicycle or

Figure 8.3 Distance to nearest bus stop

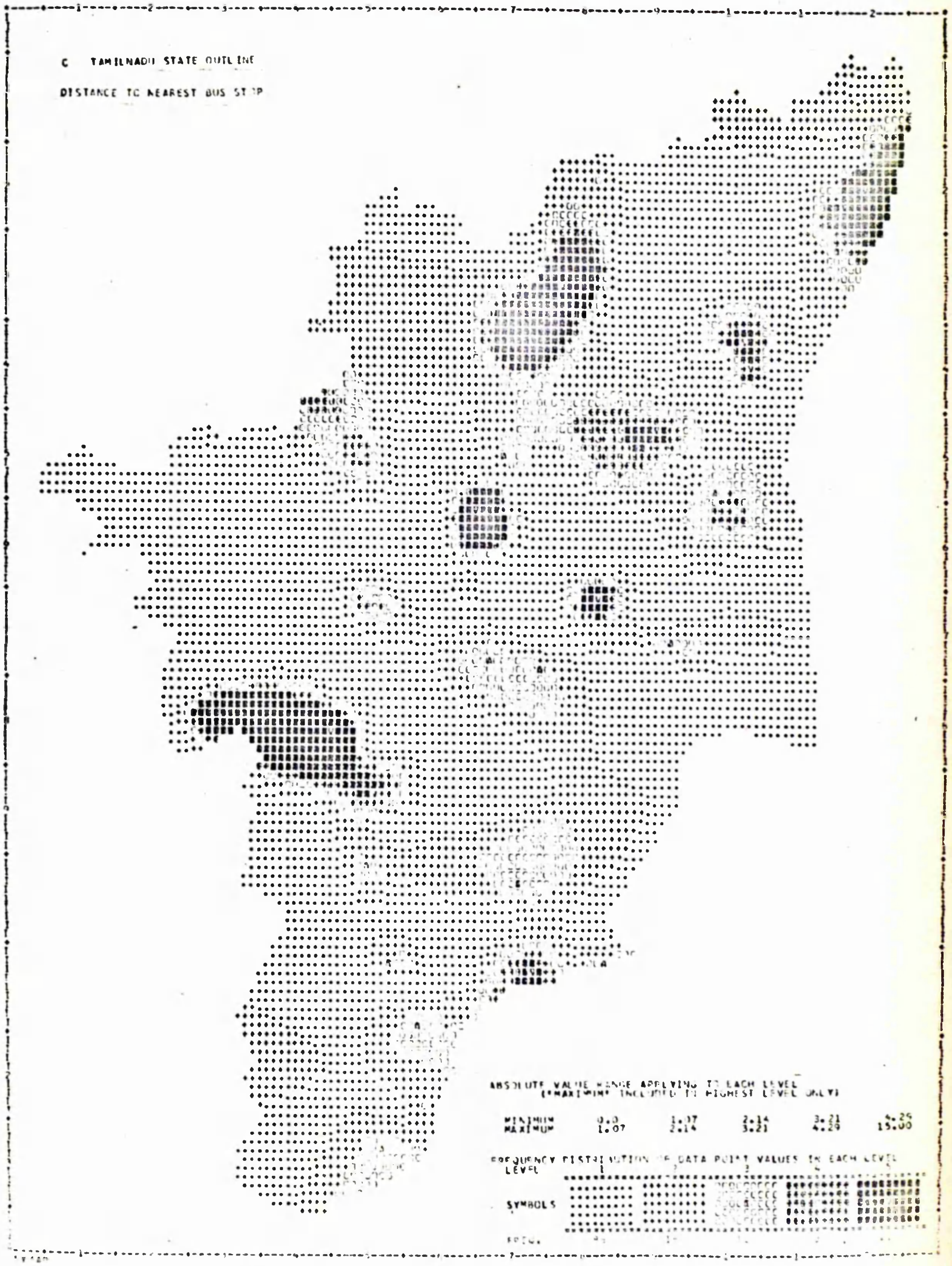
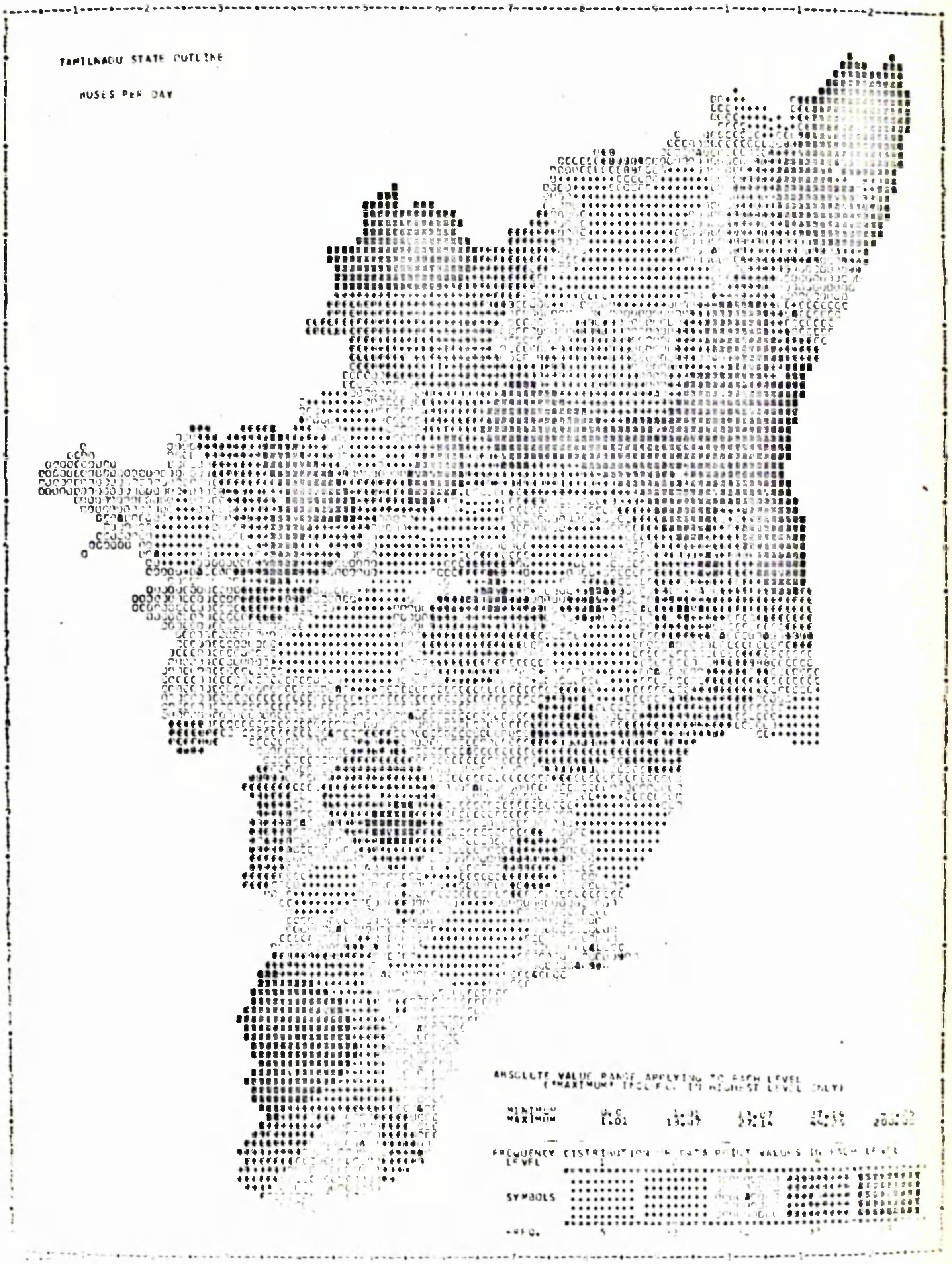


Figure 8.4 Number of buses per day

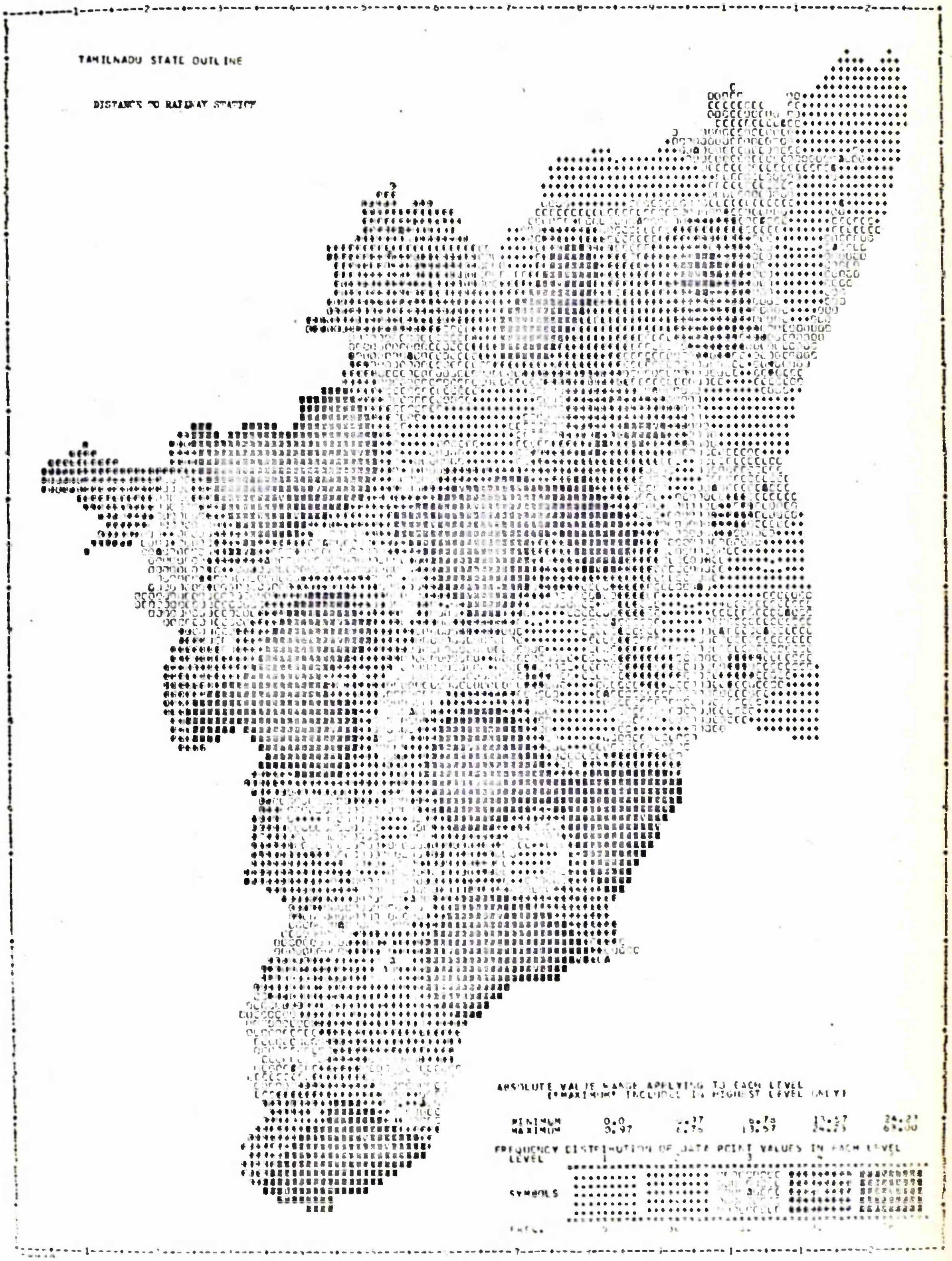


head load. Buses have become an extremely important feature of daily life both as carriers of goods and of people. To be on a bus route means to be relatively highly connected with the potential centres of change. For these reasons proximity to bus stops may be expected to be a factor at the local scale in the patterns of change.

c. Distance from a railway station. Railways also serve as major carriers of freight and people. Established for a much longer time than the bus routes, proximity to the railway carries with it accessibility not just to the urban centre but to all the larger centres in the State. Furthermore, this accessibility has been established for many years, and thus patterns of interaction are long established. Qualitatively it could be argued that the accessibility given by proximity to railways is different from that given by proximity to a bus stop. The importance of distance from a railway station in terms of the spatial patterns of change was suggested by its significance as a control variable in several of the relationships discussed in the last Chapter. In this Chapter an attempt is made to isolate the role of railway accessibility as a factor in such change.

d) Generalised accessibility. Three nodal measures of accessibility are analysed, using as a basis the calculations carried out and discussed in Chapter Six. Although in many ways it would be desirable to apply the whole range of topological and modified topological measures discussed in Chapter Six many of them are not immediately applicable to the village level focus of this part of the study. For example, it is not possible to test hypotheses relating to the structural form of networks to the patterns of change in villages. One aspect of the topological measures has however

Figure 8.5 Distance from the nearest railway station



been singled out , namely the concept of nodal accessibility. In Chapter Six this was defined according to various topologicaland modified topological criteria. In the subsequent analysis three forms of nodal accessibility measure are used, and their impact on the spatial organisation of change assessed. These are accessibility to the district level transport system, accessibility to the State level transport system (both of them measured in terms of the road networks), and accessibility to the railway network. The procedures adopted in calculating these nodal indices have been outlined in Chapter Six. In this analysis the villages are scored on the basis of the nodal accessibility of their nearest urban centre. The assumption underlying this technique is that if generalised properties of accessibility have any bearing on the village level patterns of change then these general nodal properties should embrace the hinterland villages. If this is not the case then it is clear that the general properties of the transport system have no relevance in any case. Thus while no testing of the complete range of topological indices is undertaken, by confining attention to the importance of nodal accessibility and its impact on village development one of the most important elements of topological structure is examined.

8.2 Distance to Markets

1. The most evident feature of the simple correlation coefficients between distance from the nearest weekly market and the rate of change is their frequent lack of any significance. Spatially, distance from the nearest market is positively correlated with distance from towns of 20,000, but shows no correlation with the other accessibility measures. Although several of the non-innovation measures show

some correlation with distance from the market, only two of the variables relating to such innovations show any correlation.

2. None of the agricultural variables show any significant correlation with distance from the markets, although well irrigation is negatively correlated with distance , significant at the 95% level.

3. Of the consumer variables, only two are correlated with distance from markets, the adoption of scooters and of bicycles. Radios stoves and pumpsets show no correlation with distance.

4. The correlation coefficients that are found to be significant are no higher than those discussed in the previous Chapter, and the overall picture is one of the extremely limited significance of distance from markets, On the basis of the evidence presented in the simple correlation table it can be argued that the markets play little part in spatial patterns of consumer innovation at the village level.

5. Examination of the partial correlation coefficients gives no cause radically to alter this view. The introduction of controls does not allow new correlations to appear. It does reduce the strength of those that were found in the simple correlation matrix. Only one of the variables retains a significant correlation irrespective of control, that is the number of bicycles per head.

The weakness or absence of significant correlations between distance from local markets and the variables under study suggests that despite the known importance of <u>shandies</u> in some social and economic respects, their

Table 8.1 Simple and partial correlation coefficients relating distance to market with the variables of change

Control variable	VARB	VARH	VARI	IRRIGW
r	-.1647	-.2526*	-.2362*	-.1743
DISTA	-	-.2304*	-.2011	-.1461
DISTB	-.1610	-.2507*	-.2355*	-.1761
DISTC	-	-.2251*	-.2149*	-
DISTF	-.1531	-.2378*	-.2227*	-.1715
DISTI	-	-.2295*	-.2178*	-.1705
ACCDIST	-	-.2460*	-.2361*	-.1805
ACCLAKH	-	-.2471*	-.2341*	-.1664
ACCRL	-.1688	-.2525*	-.2351*	-.1707
NOBUS	-	-.2393*	-.2213*	-.1733
VARE	-.1525	-.2337*	-.2090*	-
VARF	-.1593	-.2493*	-.2320*	-.1881
VARG	-.1516	-.2213*	-.2023*	-.1831
VARH	-	x	-	-
VARI	-	-.1561	x	- 1599
CAMKT	-.1671	-.2526*	- 2371*	-.1744
WLHYV	-.1600	-.2479*	-.2311*	-.1880
WLFERT	-.1634	-.2518*	-.2359*	- 1757
IRRIGC	-.1645	-.2505*	- 2381*	-.2152*
IRRIGW	- 1630	-.2283*	-.2261*	x
PERLITM	-.1665	-.2580*	-.2350	-.1769

r - simple correlation coefficient; ACCDIST - district-level accessibility; ACCLAKH - accessibility to the State network; ACCRL - accessibility to the rail network; CAMKT - proportion of the first crop to market.

influence over the important agricultural and consumer changes which have occurred in Tamil Nadu during the years preceding 1971 was very slight. This is not to say of course that the innovations did not pass through these centres, simply that distance from them is not a factor in the spatial organisation of such changes that have occurred. The inference that they do not even act as distribution points would of course require further testing by different methods.

8.3. Distance to Bus Stops

In pronounced contrast to the pattern of simple correlation coefficients relating to distance from markets, the coefficients relating to distance from bus stops and the indices of change show a considerable number of significant relationships.

1. Distance from a bus stop is positively correlated with distance from other foci of the transport network. At least at the local level this suggests that the pattern of remoteness being reinforced at different levels and measured by different criteria receives further support. Thus remoteness from small towns is correlated with remoteness from bus transport and remoteness from railway stations. This needs to be borne in mind in analysing the other correlation coefficients where the effects of either of these two alternative forms of accessibility might be expected to exert a controlling influence over the pattern of coefficients relating to distance from a bus stop.

2. Three of the agricultural variables show strong negative correlations with distance from a bus stop: the percentage of wet land under high yielding varieties (-.2472), the percentage of wet land with chemical fertiliser (-.2312),

Table 8.2 Simple correlation between distance from bus stops and the variables of change; partial correlation coefficients

	DISTA	DISTI	VARB	VARG	VARH	VARI	HYVA	WLHYV	WLFERT	PERLITM	PERLITF
DISTF	.2165*	.2553*	.1440	-.2078*	-.2342*	-.1942	-.2171*	-.2472*	-.2312*	-.1989	-.2389*
Control variable											
DISTA	x	.1749	-	-.1837	-.2100*	-.1580	-.1929	-.2100*	-.1736	-.1778	-.2257*
DISTB	.2044*	.2303	-	-.1922	-.2135*	-.1677	-.2052*	-.2309*	-.2142*	-.1747	-.2205*
DISTC	.2656**	.3003**	-.1569	-.2342*	-.2512*	-.2089*	-.2060*	-.2338*	-.2544*	-.1976	-.2299*
DISTD	.2009	.2454*	-	-.1977	-.2160*	-.1773	-.2191*	-.2427*	-.2302*	-.1973	-.2339*
DISTI	-	x	-	-.1535	-.1864	-.1586	-.1969	-.2085*	-.1927	-	-.1726
ACCDIST	.2154*	.2515*	-	-.2006	-.2213**	-.1942	-.2142*	-.2375*	-.2135*	-.2016*	-.2304*
ACCLAKH	.2165*	.2558*	-	-.2075*	-.2335*	-.1949	-.2207*	-.2481*	-.2310*	-	-.2394*
ACCRL	.2286*	.2702**	-	-.2042*	-.2348*	-.1986	-.2171*	-.2370*	-.2409*	-.2112*	-.2291*
VARE	.2075*	.2409*	-	-.1867	-.2146*	-.1672	-.2262*	-.2511*	-.2245*	-.1948	-.2285*
VARG	.1935	.2145*	-	x	-.1721	-	-.1735	-.2072*	-.1975	-.1701	-.1850
VARH	.1920	.2148*	-	-	x	-	-.2091*	-.2302*	-.2170*	-	-.1699
VARI	.1850	.2302*	-	-.1468	-.1572	x	-.2318*	-.2313*	-.2064*	-.1742	-.2003

(Continued over)

Table 8.2 (Continued)

Control variable	VARG	VARH	VARI	HYVA	WLHYV	WLFERT	PERLITM	PERLITF
WLHYV	-.1571	-.2142*	-.1731		x	-.1630	-.1600	-.1871
WLFERT	-.1692	-.2184*	-.1634	-.1611	-.1856	x	-.1764	-.2155
IRRIGC	-.1949	-.2263*	-.2002	-.1831	-.2187*	-.2130*	-.1779	-.2170*
IRRIGW	-.2103*	-.2294*	-.1919	-.2258*	-.2510*	-.2337*	-.2025*	-.2516*
PERLITM	-.1807	-.1872	-.1689	-.1724	-.2178*	-.2124*	x	-
PERLITF	-	-.1604	-	-.1575	-.1978	-.2068*	-	x

Second order partial correlations

	VARG	VARH	VARI	HYVA	WLHYV	WLFERT	PERLITM	PERLITF
DISTA + WLHYV	-.1441	-.1985	-.1466	-	x	-	-.1480	-.1839
DISTA + PERLITM	-.1610	-.1707	-	-.1540	-.1858	-.1610	x	-
DISTA + PERLITF	-	-	-	-	-.1638	-.1532	-	x

and the proportion of the main crop under high yielding varieties (-.2171). The first of these is significant at the 99.9% level, the latter two at the 99% level.

3. Three of the consumer variables also show significant negative correlation coefficients: the proportion of the village population with bicycles (-.2342), the proportion of the population with radios (- 2078), and the proportion of the population with scooters (-.1942). Thus the influence of distance from a bus stop appears to extend over both agricultural and non-agricultural variables.

4. Despite this apparent influence, it is clear once again that the level of explanation remains very low, albeit highly significant in statistical terms. It can also be noted that the coefficients are similar to those found relating to distance from the smaller towns, though the overlap is by no means complete. However, the question raised by this pattern of overlapping relationships is to what extent the patterns are truly independent. Again therefore the partial correlation analysis can be expected to shed some light on this question.

5. Unlike the pattern of correlation coefficients found for the three urban groups, the pattern of significant relationships relative to distance from bus stops is more stable through the first order partial correlations. As can be seen from Table 8.2 distance from small towns accounts for some of the correlation for several of the variables although in no case does it reduce the coefficient to insignificance. Similarly when distance from the 100,000 cities is controlled some of the variance explained is reduced although by a lesser amount. At the first order, however, two variables are found to be of particular significance as controls.

For the consumer variables the proportion of bicycles owned in the village, when applied as a control to the other consumer variables which show a significant correlation with distance from a bus stop, reduces them to insignificance. Thus both ownership of radios and of scooters appears to reflect the controlling influence of the proportion of the population that owns bicycles. There is no apparent reason why this should be the case. However, as was argued in the introduction, there is clearly a strong degree of outside interference acting on the variables being measured. Thus while distance has an effect on the spatial pattern of adoption of bicycles, it could well be that the adoption of bicycles is itself a surrogate variable for other unmeasured variables such as income per capita in the village. The use of one of the measured variables as a control also carries with it the probability of controlling for the underlying variable as well. Thus it has to be accepted that the reduction of significance of a correlation coefficient by a particular control may not be the direct result of the influence of that control variable itself but the indirect result of the influence of a co-varying but unmeasured control variable.

In addition to the importance of the number of bicycles as a control variable at the first order, one other control variable has an important effect. When female literacy is controlled the proportion of the population with radios no longer shows a significant negative relationship with distance from bus stops Although it is possible that literacy too is in some way a surrogate variable , it is at least evident that distance from bus transport has a measurable impact on literacy itself. Its role is discussed further below.

6. When distance from the 1,000,000 cities is controlled there is a slight increase in the coefficients, sufficient to allow two further variables to be seen to have a significant negative correlation with distance from bus stops. These are the number of stoves (-.1518) and the number of electric pumpsets (-.1467). Neither of these coefficients is high, and they are only significant at the 95% level. Although only a very low proportion of the variance is explained its significance is retained through the second order partials when distance from the 1,000,000 cities is one of the two variables being controlled. Thus it appears that the whole range of consumer variables is to some degree influenced by the distance of the village from a bus stop.

7. The agricultural variables also show relatively little interference by control variables at the first order. Controlling for distance from smaller towns has some effect on the coefficients although it is only a slight one. The coefficient for wet land under fertiliser is reduced from -.2312 to -.1736, while the effect on the other two variables (wet land under high yielding varieties and proportion of the main crop under fertiliser) is less pronounced. When distance from the 1,000,000 cities is controlled, the correlation coefficient for wet land under fertiliser rises, but the other two agricultural variables show no such increase.

8.4 Distance to a Railway Station

From the simple correlation coefficients it would appear that distance from a railway station also has a bearing on the pattern of adoption of consumer and agricultural innovations. The role of distance from a railway station

Table 8.3 Correlation coefficients relating to distance from a railway station

Simple correlation coefficients

	DISTA	DISTB	DISTC	DISTF	NOBUS	VARB	VARC	VARE	VARF	VARG
DISTI	.4931**	.2886**	.2806**	.2553**	.2580*	-.1867	-.1455	-.1723	-.2305*	-.2513*

	VARH	VARI	HYVB	WLHYV	WLFERT	PERPAD	PERLITM	PERLITF
DISTI	-.2222*	-.1686	-.1443	-.1952	-.1886	-.2062*	-.2973**	-.3152**

* Significant at the 99% level
** Significant at the 99.9% level

as a control variable has already been seen to be of importance, and thus the existence of significant correlations in the simple matrix was to be expected. However, the extent to which these correlations are themselves independent is examined below.

1. Villages remote from a railway station are also remote from urban centres. The strong positive correlations between distance from a railway station and other accessibility variables (as high as +.4931 between distance from a railway and distance from a small town) adds weight to the evidence discussed above. It also suggests the importance of attempting to disentangle the components of the correlation coefficients between railway accessibility and the variables of economic and agricultural change.

2. Six of the consumer variables show significant negative correlations with distance from railway stations. Electric pumpsets (per acre and per head of population), stoves, radios, bicycles and scooters all have negative correlation coefficients of between -.1455 and -.2513. This suggests influence of railway accessibility over as wide a range of variables as for any of the other forms of accessibility.

3. Three of the variables relating specifically to agricultural change also show a correlation with distance from a railway station. These are the percentage of the second crop sown to high yielding varieties (-.1443), the percentage of wet land under high yielding varieties (-.1953) and the proportion of wet land under chemical fertiliser (-.1886).

4. In addition to the variables which it is the chief aim of this thesis to analyse, it is noteworthy that several other variables are

Table 8.4 Partial correlation coefficients relating distance from railway stations to the variables of change : first order controls

Control variable	VARB	VARC	VARE	VARF	VARG	VARH	VARI	HYVB	WLHYV	WLFERT
DISTA	-	-.1509	-	-.2029*	-.2119*	-.1803	-	-	-	-
DISTB	-	-	-	-.1965	-.2190*	-.1768	-	-	-.1534	-.1472
DISTC	-.1659	-	-	-.1768	-.2106*	-.1938	-.1446	-.1521	-.2318*	-.1504
DISTF	-.1567	-	-.1492	-.2080*	-.2096*	-.1732	-	-	-	-
ACCDIST	-.1843	-.1466	-.1763	-.2254*	-.2479*	-.2170*	-.1683	-	-.1885	-.1881
VARC	-.1766	x	-	- 2309*	-.2227*	-.2049*	-.1507	-.1545	-.2905*	-.1725
VARE	-.1702	-	x	-.2353*	-.2186	-.1928	-	-.1483	-.1999	- 1785
VARG	-.1631	-	-	-.1506	x	-.1450	-	-	-	- 1455
VARH	-	-	-	-.2135*	-.1877	x	-	-	-.1754	-.1736
VARI	-	-	-	-.2114*	-.2048*	-.1600	x	-	-.1783	-.1659
WLHYV	-.1734	-.1666	-.1796	-.1968	-.2416*	-.2068*	-.1508*	-	-	-
WLFERT	-.1719	-	-.1612	-.2166*	-.2218*	-.2098*	-	-	-	-
IRRIGC	-.1866	-.1576	-.1789	-.2319*	-.2512*	-.2215*	- 1694	-.1510	-.2038*	-.1888
IRRIGW	- 1859	-	- 1687	- 2439*	- 2540*	-.2187*	-.1660	-.1480	-.1973	-.1912
PERLITM	-.2131*	-.1636	-.1656	-.1934	-.2141*	-.1504	-	-	-.1465	-.1603
PERLITF	-.1900	-.1437	-	-.1715	-.1655	-	-	-	-	- 1553

* Significant at the 99% level

also correlated strongly with distance from a railway station. Both demographic and occupational data have been used in the earlier stages of the analysis to test for their possible importance as control variables. Thus such variables as literacy, percentage of the workforce in agriculture and in the different categories of manufacturing activities have been examined with reference specifically to their impact on the correlation coefficients between accessibility and the variables of village level change. Nearly all of these variables have been shown to play very little part in the presence or absence of significant correlation coefficients for these other variables, and themselves have shown little evidence of correlation with the accessibility variables. However, several of these variables are correlated with distance from a railway station. It is not the purpose of this study to enquire into the reasons for such patterning, but it is of importance to assess the possible bearing of these patterns on the other correlation coefficients. Thus the possible controlling influence of literacy is suggested by negative correlation coefficients of -.2973 and -.3152 for male and female literates respectively, and the effects of these factors on the variables under examination is analysed below.

5. Although the levels of significance are higher than those for some of the other forms of accessibility they nonetheless remain very low. The level of explanation is never higher than 10% and is generally far lower. Thus again the simple correlation coefficients lend weight to the view that although distance from a railway station may be a factor affecting the adoption of new agricultural techniques and the spread of new consumer goods, it plays at most a very small part.

6. The possibility that some of the demographic and occupational characteristics may be acting as controls over the patterns of adoption is only one further complicating factor in what is already a complex situation. For the large number of significant correlations with the other accessibility variables, and among the consumer variables themselves, makes it possible that there are one or two variables that control the general pattern. It is necessary therefore to examine the extent to which the simple correlation coefficients indicate genuinely independent relationships.

7. The first order partials show general stability of relationship between distance and consumer variables. There are some notable exceptions, however.

a. The negative correlation between the number of travellers from the village per day and distance from a railway station is removed when either distance from the small or from the intermediate cities is controlled. It is also removed by control for the number of bicycles or the number of scooters per head. This implies that it is distance from other urban centres rather than from a railway station which affects the volume of movement out of villages. Although this is not itself a consumer variable it is the most direct indication of interaction with the centres from which consumer goods are obtained and is therefore potentially an important link in the chain of accessibility connecting patterns of change with measures of accessibility. That there is no independent correlation with distance from the railway station is the first indication that such distance may be less significant than implied by the simple correlation coefficients.

b. When distance from the 20,000, 100,000 and 1,000,000 cities is controlled, the significant relationship between distance from railway stations and the adoption of electric pumpsets also disappears. The significant correlation is caused to disappear by controlling for some of the consumer variables, though it could be inferred that these in turn simply reflect the accessibility of the village measured by the other indices, and that those forms of accessibility produce the significant correlation. In either case it is evident that the simple correlation is a spurious relationship. The first order partials do not make it possible to determine which of the variables is fundamentally responsible for producing the spurious correlation. However, two variables are seen to act in the opposite direction, in that when accessibility to the district network and when the proportion of wet land under high yielding varieties are held constant the correlation coefficient between distance from a railway station and the adoption of electric pumpsets increases. The possibility that these two variables are masking an independent relationship is examined through the second order partial correlations.

c. The other consumer variables retain their significant relationship with distance from a railway station. The strength of the correlations is reduced by nearly all of the conrol variables, the adoption of radio sets being least affected. The greatest reduction in the coefficient occurs when the proportion of female literates is the control ($r = -.1655$). The effect of literacy on the significance of the coefficients is striking, and its control shows that the relevance of distance from a railway station to the pattern of distribution of new consumer goods is at most very weak.

d. Second order partials show further reductions in the statistical significance of the relationship, and when female literacy is one of the joint controls no significant correlations remain among the consumer variables.

e. First order partials suggest that the apparently significant relationships between distance from a railway station and the patterns of adoption of new agricultural inputs is also spurious. When distance from the 20,000 towns is controlled all the significant correlations all disappear. Distance from a bus stop (itself controlled by distance from towns of 20,000), and the use of high yielding varieties and of fertilisers also cause the significant relationships to disappear. Furthermore, none of the control variables cause an increase in the correlation coefficients. Thus the partial controls at the first order suggest that distance from a railway station is not an important factor in the spread and adoption of new agricultural techniques or inputs.

f. The second order partials lend further support to the conclusions suggested by the first order controls. Most of the second order controls result in further reduction of the statistical significance of the correlation coefficients . Thus when the two controls are distance from towns of 20,000 and the proportion of the population with radios not one of the variables shows a significant relationship with distance from a railway station. The counteracting role of district level accessibility is still suggested by its contribution to maintaining a significant correlation for some of the consumer variables, but they are only just significant at the 95% level. Thus the evidence of direct influence exerted by distance from a railway station on the patterns of agricultural and consumer change is very slight.

Table 8.5 Second order partial correlation coefficients relating to distance from a railway station

Control variable	VARB	VARC	VARE	VARF	VARG	VARH	VARI	HYVB	WLHYV	WLFERT
DISTA + DISTB	-	-	-	-.1727	-.1833	-	-	-	-	-
DISTA + DISTC	-	-	-	-.1893	-.1928	-.1679	-	-	-	-
DISTA + DISTF	-	-	-	-.1893	-.1857	- 1491	-	-	-	-
DISTA + VARG	-	-	-	-	x	-	-	-	-	-
DISTA + VARH	-	-	-	-.1902	-.1612	x	-	-	-	-
DISTA + PERLITF	-	-.1501	-.1444	-	-	-	-	-	-	-
DISTB + VARG	-	-	-	-	x	-	-	-	-	-

Analysis of the patterns of correlation between distance from a railway station and the socio-economic variables used in this study shows that first appearances can be deceptive, and that distance from a railway station is not a critical factor in whether or not villages are more or less advanced in terms of their adoption of new techniques and inputs. While it would appear that several variables are distributed with reference to distance from the nearest railway station, the evidence of the partial controls suggests that such patterns reflect no more than the indirect influence of other influential forces. It is clear for example that distance from towns of 20,000 is a considerably more important factor in the distribution of some agricultural variables than is distance from a railway station. Similarly it has been shown that distance from towns of 100,000 plays a more important role in the distribution of some consumer variables than does distance from the railway.

In these respects the role of bus transport would appear to differ significantly from that of rail transport within the spatial economy of the villages of Tamil Nadu. For although it is true that the coefficients of correlation relating distance from the bus stops were also low and rarely explained more than 10% of the variance they were shown to be stable through controls and in some cases to increase the level of their significance. In contrast the coefficients relating to distance from railway stations were shown to disappear almost without exception when controls were introduced.

8.5 Generalised Accessibility and Patterns of Change

It remains to examine the role of generalised accessibility in the spatial patterns of adoption of new agricultural techniques and of consumer goods. Three of the generalised indices of the structure of accessibility are examined: district level accessibility, accessibility to the State level network and accessibility to the rail network.

8.6 Accessibility to the District Level Network

1. The most striking feature of the pattern of correlation coefficients relating to the generalised measures of accessibility at the district level is the very small number of significant relation ships. Only two of the consumer variables show any correlation with accessibility at the district level. Equally only two of the agricultural variables show any such correlation.

2. As predicted the relationships are positive, but even those coefficients that are statistically significant are very low in three of the four cases. Only the proportion of wet land under fertiliser has a coefficient of correlation significant at the 99.9% level, but even then the percentage of the variance explained is less than 5%.

3. Of the consumer variables only the number of stoves and the number of bicycles are correlated with accessibility. Of the agricultural variables the proportion of wet land with fertiliser and the proportion of the second crop under high yielding varieties show significant positive correlations.

4. The overall lack of influence exerted by the structure of the district level transport network is very clear. The partial correlation coefficients reinforce this view, with only one exception. The first order partial correlation coefficients show that the pattern of distribution

Table 8.6 Correlation coefficients relating to district-level accessibility

Control variable	VARH	HYVB	WLFERT	IRRIGC
r	.1670	.1951	.2601**	.2255*
DISTA	-	.1941	.2582**	.2252*
DISTB	.1646	.2116	.2724**	.2354*
DISTC	-	.1899	.2325*	.2239*
DISTD	-	.1933	.2501*	.2240*
DISTF	-	.1846	.2349*	.2167*
DISTI	-	.1884	.2455*	.2256*
ACCLAKH	.2105*	.2772**	.2640**	.2858**
ACCRL	.1606	.2428*	.3087**	.2537*
WLHYV	-	.1492	.2236*	.1933
WLFERT	-	-	x	.1858
IRRIGC	-	-	.2157*	x
PERLITF	-	.1729	.2399*	.2067*
DISTA +DISTB	-	.2094*	.2762**	.2335*
DISTA + DISTC	-	.2005	.2514*	.2271*
DISTA + ACCLAKH	.2092*	.2788**	.2711**	.2849**
DISTA + IRRIGC	-	-	.2273*	x
DISTB + ACCLAKH	.2145*	.2799**	.2693**	.2866**
DISTA + DISTB + ACCLAKH	.2131*	.2810**	.2754**	.2856**

* Significant at the 99% level
** Significant at the 99.9% level

r - the simple correlation coefficient between distance from a railway station and the variables of change.

of high yielding varieties grown as a second crop is more highly correlated with generalised accessibility at the district level than was suggested by the simple correlation coefficients. When other variables are controlled the level of significance increases markedly. The most important of the masking variables is generalised accessibility to towns of 100,000. When this is controlled the correlation coefficient rises to +.2772, significant at the 99.9% level. Second and third order controls, keeping distance from 20,000 towns and distance from 100,000 towns constant, further increases the correlation coefficient slightly. The correlation coefficient for the proportion of wet land under fertiliser is also increased when controls are applied, but the two most influential controls in this case are accessibility to the railway network and distance from towns of 100,000. When these two variables are controlled together the correlation coefficient rises to +.3138.

Despite these increased coefficients which suggest that district level accessibility plays some part in the spatial organisation of change the overall impression given is that of a low degree of influence. This lack of influence is further suggested by the fact that the partial controls completely remove the significance of the other relationships, leaving only the two agricultural variables showing any correlation with generalised district level accessibility.

6. The lack of correlation between most of the variables of change and the generalised structure of the transport network at the district level does not mean that such accessibility is not a factor in the development process or an element of underdevelopment.

It does mean however that in terms of the ability or willingness to introduce new techniques into agriculture and to purchase recently introduced consumer goods this measure of accessibility has little or no significance. It is only in two aspects of the rural economy that district level accessibility has any importance, the use of fertiliser on wet land and the adoption of high yielding varieties of seed for the second crop. Both of these variables have shown the infl uence of accessibility to urban centres, and the evidence of this analysis points to this further aspect of accessibility as a factor of relevance. However, it has to be remembered that both the variables are relevant only to irrigated land. Thus the importance of generalised accessibility is restricted not only in terms of the range of variables affected but also by the regional distribution of irrigated land.

8.7 Accessibility to the State-Level Network

1. Generalised accessibility at the State level has even less bearing on patterns of change than does accessibility at the district level. Only four dependent variables show any degree of correlation with accessibility measured on this scale. These are the proportion of high yielding varieties (both first and second crops), the proportion of farmers using chemical fertiliser and the proportion of the population with bicycles.

2. None of the correlation coefficients is significant at higher than the 95% level. This very low level of explanation suggests that such correlations as there are may well be spurious, though the masking effect of other variables cannot be ruled out. Examination of all the variables other than the proportion of the

Table 8.7 Correlation coefficients between State-level accessibility and variables of change

Control variable	VARH	HYVA	HYVB	FFERT	IRRIGW
r	.1490	.1500	.1581	.1631	.1572
DISTA	-	-	-	-	.1567
DISTB	-	-	-	.1795	.1692
DISTC	-	-	-	-	.1571
DISTI	.1489	.1485	.1574	-	.1613
ACCDIST	.1952	.1655	.2427*	-	-
VARG	.1469	.1521	.1568	-	.1530
PERLITF	.1769	.1823	.1790	-	-
DISTA + VARG	.1466	.1519	.1579	-	-
DISTA + ACCDIST	-	.1651	.2461*	-	-
DISTA + DISTB	-	-	-	-	-
DISTA + DISTC	-	-	-	-	-
DISTA + DISTB + ACCDIST	.1620	.1476	.2227*	.1632	.1533

* Significant at the 99% level

second crop sown to high yielding varieties shows that such correlation coefficients as existed in the simple matrix disappear when controls are introduced. Even the correlation coefficient for high yielding varieties grown as a second crop, which is increased when district level accessibility is controlled, is reduced to insignificance when the proportion of wet land under fertiliser is introduced as a joint control variable. Thus the evidence is almost conclusive that the generalised index of accessibility at the State level has no bearing on the spatial organisation of those elements of change under examination in this study.

8.8 Accessibility to the Railway Network

1. Generalised accessibility to the rail network shows an equal lack of importance. Correlation coefficients are positive and significant with respect to only one variable, the proportion of electric pumpsets in the village. There is one negative correlation, with the adoption of high yielding varieties on wet land. The level of significance is very low.

2. The partial correlation analysis reveals that the simple correlation coefficients are insubstantial, and the significance of both is removed by several of the variables.

3. The conclusion is clear that the effect of generalised accessibility to the rail network has no real bearing on the spatial patterns of recent change at the village level in terms of the variables under study.

Table 8.8 Correlation coefficients relating accessibility to the rail network and variables of change

Control variable	VARE	WLHYV
r	.1552	-.1497
DISTA	.1531	-.1494
DISTB	-	-.1680
DISTC	-	-
ACCLAKH	.2013	-.1789
IRRIGW	-	-
DISTA + DISTB	-	-
DISTA + DISTC	-	-
DISTA + ACCLAKH	.1927	-.2083
DISTB + ACCLAKH	.1868	-.2026

8.9 Conclusion

Distance from markets, bus stops and railway stations have been shown to have a variable degree of influence over the spatial patterns of adoption of new consumer goods and of agricultural innovations. As was shown in Chapter Seven, accessibility is clearly only one of the factors affecting the development of such spatial patterns. In this Chapter it has been shown that the introduction of a series of different measures of accessibility, while indicating the independent significance of some generally confirms their relatively small contribution to patterns of change.

Of the measures of accessibility analysed in this Chapter only distance from a bus stop and from a railway station are significantly correlated with innovation and adoption patterns. The most significant and stable factor has been shown to be that of distance from bus stops, retaining its significance irrespective of the influence of other relevant factors such as distance from towns, literacy rates and occupational structure. The evidence of this Chapter points firmly to the conclusion that this is the only aspect of the measures of accessibility discussed which exerts such an influence. While distance from a railway station appeared to be an equally significant factor from the simple correlation tables, the institution of partial controls showed that its influence was almost entirely secondary in nature, simply reflecting the primary influence of other factors. Of these other factors literacy was found to be most important. Itself negatively correlated with distance from both bus stops and railway stations, its control removed all significance from the relationship between distance from a railway station and agricultural or consumer innovation.

Finally, it was shown that those measures of the topological structure of the transport network introduced earlier had little direct impact on the spatial patterns of change. This is not to say that the structure of transport networks is irrelevant to levels of development within districts or between regions. However, it does imply that in terms of village level patterns of change generalised topological accessibility is of only marginal importance. This finding could reflect at least in part the crudity of the indices of topological structure used in the analysis, itself a reflection of the weakness of the data relating to networks in Tamil Nadu. However, there is very little evidence to suggest that nodal accessibility as measured by topological indices has more than marginal significance for recent patterns of agricultural development and change.

The analysis presented in this and the previous Chapter has shown that distance and accessibility do play a part in the nature and pace of change at the village level in Tamil Nadu. The analysis has made it possible to refine considerably the nature of that influence and to assess its strength. It has been shown that despite its crudeness as a measure of accessibility distance to the nearest town is a more significant factor than any other, and that it is also the most independent factor. The variables of change have however been shown to respond in differing degrees to urban accessibility. In general the variables of agricultural change (proportion of wet land under high yielding varieties, proportion of wet land under chemical fertiliser, proportion of villagers with electric pumpsets) showed the influence of proximity to towns in the 20,000 size group to be considerably more important than any other form of accessibility. Although the predicted negative correlation coefficients were low and the proportion of unexplained variance correspondingly high, the significance of the correlations was generally greater than 99%. Alongside the role played by the smaller towns must be set the finding that distance from a bus stop was also negatively correlated with patterns of adoption. This finding ties in closely with the importamce of smaller towns, as it is this class of town which is generally the focus of the transport system. Thus despite the clear indication that distance from urban centres is only one of the factors spatial patterns of change, the evidence supports the conclusion that it is a significant element within the complex system of agricultural change.

While the smaller towns have been shown to play a significant role in the adoption patterns of new agricultural techniques, it is distance from the larger cities that has been shown to be a more influential factor in the patterns of adoption of the new consumer variables. Radios, stoves and bicycles have all been shown to be negatively correlated with distance from cities of 100,000 and above. This suggests not only their distributive role but also their centrality in terms of purchasing power. The corresponding pattern of relationship between consumer goods and distance from the nearest railway station also fits into this general pattern, in so far as the railway lines focus without exception on cities of this size class. However, the low coefficients and their instability under control means that little weight can be placed on this as as a major factor.

From the analysis of the last two Chapters it is clear that elements of systematic spatial organisation were operating in Tamil Nadu and played a part in the spatial organisation of village level change which had occurred by 1971. It remains to examine the relationship between these systematic factors of accessibility and the characteristics of the regional environment which were shown in the earlier Chapters to be important. For it is the interplay of the regional factors with the systematic influences which have led to the regional contrasts in village development patterns in Tamil Nadu. This interplay is examined in the concluding Chapter.

CHAPTER NINE

Conclusion

In this study an attempt has been made to analyse the processes underlying the regional and spatial contrasts in development and change in Tamil Nadu. Since India's Independence in 1947 the pace and nature of economic development has both quickened and changed. In the explicit acceptance by both State and Central Governments that economic growth was a fundamental goal of domestic politics lay the seeds of potential increase in economic disparities. It was the equally explicit intention of Government not only to prevent the growth of such disparities but also to remove such disparities as had been inherited from the British period. By 1971 it was apparent that such aims had not been realised, yet remarkably little work had been done on the processes by which economic disparities increased or the means by which they could be diminished. Thus it was the aim of this thesis to examine a limited aspect of economic change in one of the more economically dynamic States in India in order to try and assess the contribution both of regional and of systematic factors to the processes of regional development.

In view both of the dominance of agriculture in the economy of Tamil Nadu and of the high proportion of the population living in villages the analysis focussed on aspects of rural development. In the first five Chapters the analysis focussed on the regional characteristics of the State and structure of the agricultural system which had a bearing on the patterns of development.

This macro-level analysis highlighted several important relationships which have influenced the patterns of regional development in Tamil Nadu, and which by 1971 had contributed to the growing regional contrasts. Of the elements of the physical sub-system which were found to be relevant, the availability of assured water supplies was shown to be particularly critical. Districts which inherited extensive areas of land under reliable irrigation (notably Thanjavur, but also to a lesser extent South Arcot and Coimbatore) were in a position to take advantage of innovations in agriculture which helped to transform production of some of the crops. Although the area receiving reliable irrigation increased steadily between 1947 and 1971 40% of the total irrigated area was still watered by tanks, and less than 20% of the total area of the State received canal irrigation. One of the most significant improvements in irrigation was the direct result of village electrification, that is the application of power pumping to well irrigation. Areas that were untouched by improvements in irrigation however were almost uniformly in a disadvantaged position with respect to other forms of agricultural development, and it was shown in Chapter Four that this was clearly reflected in the regional pattern of changes in agricultural output. The contrast was shown to be particularly marked during the last ten years of the period, when technical innovations such as chemical fertiliser and high yielding varieties of seed began to make their impact on irrigated crops, leaving the dry areas unaffected.

By 1971 the contrasts between the dry lands and the irrigated lands was one of the most striking features of the broad regional patterns of agricultural activity and of agricultural change.

The macro-level analysis of the first five Chapters allowed these contrasts to be examined, and also made possible an examination of the role played by other components of the agricultural system in the development of regional contrasts. Attempts by the State Government to overcome both social and regional inequities through legislative and administrative action were discussed in Chapter Five. It was shown that despite the universal application of the Community Development scheme by 1971 the programme of legislative action had failed to bring greater regional equity to the backward regions of the State. Indeed, it was not until the Fourth Five Year Plan that a problem was officially recognised to exist.

While the contrasts in agricultural practice are clearly of considerable significance for village level patterns of development, many questions remain unanswered by a macro-level approach. Thus although the analysis of the role of contrasts in the regional character of the environment has been shown to be of more than simply conventional importance to an understanding of the broad patterns of agricultural change, it did not allow what have been termed systematic factors to be analysed. Of these a body of theoretic work suggested that urban accessibility should be particularly important. The second part of the thesis concentrated therefore on the role played by accessibility to urban centres in the spatial patterns of agricultural and non-agricultural change at the village or micro-level.

In order to assess the part played by urban centres as foci influencing the spatial organisation of the economic hinterland, it was necessary to refine the concepts of accessibility. It was shown that while distance to the nearest town was one measure of urban accessibility it was inadequate on its own as an index of potential urban influence. Several alternative measures of urban accessibility were discussed and then applied to the analysis of spatial patterns of village level agricultural and non-agricultural change.

The study of the relationship between urban accessibility and the spread of some of the more significant elements of agricultural and consumer change has brought to light several important features relating to the spatial process of development within Tamil Nadu. First, it was shown in Chapter Six that there are pronounced contrasts in accessibility within the State, but that the nature of the definition of accessibility adopted had a crucial bearing on the patterns which were found. Thus the importance of clarifying the concept of accessibility was emphasised. It was shown that at the State level accessibility to the transport network linking the major towns was highest at the centre of the region and declined towards the borders of the State. District level accessibility contrasted strongly with this pattern, some of the peripheral districts being the most highly interconnected. Having established that it was possible to apply the concepts of topological structure and nodal accessibility developed and applied elsewhere, the relevance of these measures to village development was tested.

The analysis presented in Chapter Seven and Chapter Eight suggested the following conclusions.

1. That accessibility, however measured or defined, rarely explained more than a small proportion of the variance in the data when correlated with the variables of change.
2. Despite the low level of explanation, for every index of accessibility there were found to be some variables of change with a consistent and significant correlation.
3. Direct measures of accessibility were found to have a more significant relationship with

village development than the structural properties of the transport networks. This is not to say that such properties are unimportant, but that it has been clearly demonstrated that in terms of village level patterns of change their impact is negligible.

4. Direct accessibility, both to towns and to the means of communicating with towns, varied in importance according to the variables. It was shown that relatively high and consistent correlations were found between distance from towns in the smaller size group and use of chemical fertiliser on wet land. In contrast the larger urban centres were ahown to have a much greater degree of influence over the pattern of adoption of new technology and consumer goods. Thus it has been shown possible to disentangle some of the complex threads of the process which had produced the patterns of village level change in Tamil Nadu by 1971.

Despite these positive conclusions which have been drawn from the analysis of the preceding Chapters, a number of further points need to be emphasised. First, the use of controls in the correlation analysis has made it clear that in practice many of the variables are highly interlinked. Many of those variables which were apparently correlated with indices of urban accessibility were in fact spuriously correlated and were showing correlations as the result of the overriding influence of other variables. Thus the number of independent variables was considerably more restricted than would have appeared from the first stage of the analysis. From this fact it can also be seen that the influence of urban accessibility is of even more restricted significance as a factor in the spatial processes of change at the village level than would otherwise have been supposed. The analysis carried out in the preceding Chapters has not been designed to examine whether or not urban centres of different sizes act as the mediators of change, but whether or not distance from the cities affects the pace and nature of the changes which have occurred. The broad conclusion must be a qualified negative. This is to say that the evidence of the previous three Chapters strongly suggests that the spatial and regional patterns of village level change reflect a variety of factors of which urban accessibility is generally only a minor one. Some of these other variables were suggested by the controlling analysis itself. The importance of literacy as a control of some of the relationships for example made it clear that its influence would merit further investigation. The same may be said of some aspects of the occupational structure of the village. Others, not amenable to the particular form of statistical analysis adopted, may nonetheless play a significant role . For some of these, such as caste structure or land ownership and land-holding size , there are strong theoretical reasons as well as empirical evidence to suggest their importance. As was made clear at the outset, the exclusion of such factors as these from the analysis was based on the need to use a technique which allowed specific and very limited hypotheses to be tested which could not be tested in any other way.

The results of the analysis point to a further conclusion. Having drawn attention to some systematice elements of patterning in the processes of change the correlation analysis of the preceding Chapters has made it clear that there are many villages which do not conform to the straight line regression relationship. In the discussion above attention has been focussed only on the existence and form of relationship between the variables of change and accessibility. In order to take the analysis a stage beyond this point it would be possible to isolate the residuals from the regression and make a special study of the villages which do not conform to the spatial patterns predicted by the nature of the regression line. As such this study suggests a second stage of analysis which could examine the causes of deviation from the predicted patterns on a sound footing.

As it is such a further stage is beyond the scope of this thesis. However, it has been clearly demonstrated that both the broad regional characteristics of the environmental background of village level economic activity and some sytematic forces have a measurable bearing on the general character of change in Tamil Nadu in the period between Independence and 1971. Although the range of hypotheses to be tested made essential a wide-ranging field based research frame which imposed inevitable constraints on the analytical procedures adopted, it has been shown possible that it is essential to examine not only the systematic forces that might be expected to operate in the ideal economic landscape but also the still crucially important character of the resource endowment.

Appendix 1

The questionnaire

District Taluk Village

Population 1961

1971

1. Distance to town 20,000
2. Distance to town 100,000
3. Distance to town 1,000,000
4. Distance to nearest shandy
5. Distance to most used shandy
6. Distance to nearest bus stop
7. Distance to nearest railway station
8. No. buses per day
9. No. travellers from village per day
10. No. people to shandy
11. % of total crop to market
    a. 1st crop
    b. second crop
    c. third crop
12. % of crop sold
    a. through agents
    b. direct
13. % goods to market by bullock cart
14. % goods by lorry
15. Time by bullock cart to shandy
16. Cost per km. by bullock cart
17. Cost by lorry

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18. No. of tube wells in village
19. No. of electric pumpsets
20. No. diesel pumpsets
21. % houses electrified
22. No. petromax lights
23. No. oil cooking stoves.
24 No. radios
25 No.scooters
26 No. tractors

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27. % farmers using high yielding varieties
    a. first crop
    b. second crop
    c. third crop
28. % area under h.y.v. seeds
    a. wet land
    b. dry land
29. % farmers using fertiliser
30. % wet land with fertiliser
31. % dry land fertiliser
32. Average expenditure on fertiliser
    a. first crop
    b. second crop
    c. third
33. Recommended expenditure on fertiliser.
    a. first crop
    b. second crop
    c. third crop

Appendix 1 (Continued)

34. Average expenditure on fertiliser - dry land
    a. first crop
    b. second crop
35. Recommended expenditure on fertiliser - dry land
    a. first crop
    b. second crop
36. % of farmers using irrigation water
37. % of area irrigated
    a. canal
    b. well
    c. tank
38. % tenancy
39. % paddy
40. No. of people living in village working outside(daily)
41. No. of people from village living in Madras.

The implementation of the questionnaire is discussed in the text (Chapter Two).

Appendix 2

Tamil version of the questionnaire

மாவட்டம் ....   வட்டாரம்...........   கிராமம்....

1. கிராமத்திற்கும் 20,000 மக்கள் தொகையுள்ள ஊருக்கும் இடையே உள்ள தூரம் என்ன?

2. கிராமத்திற்கும், 100,000 மக்கள் தொகை கொண்ட நகரத்திற்கும் இடையே உள்ள தூரம் என்ன?

3. கிராமத்திற்கும் 10,00,000 மக்கள் தொகை உள்ள நகரத்திற்கும் இடையே உள்ள தூரம் என்ன?

4. கிராமத்திற்கு மிக அருகாமையில் உள்ள சந்தையின் தூரம் என்ன?

5. கிராமத்திற்கும் பஸ் நிற்குமிடத்திற்கும் இடையே உள்ள தூரம் என்ன?

6. கிராமத்திற்கு அருகில் உள்ள ரயிலடியின் தூரம் எவ்வளவு?

7. கிராம பஸ் போக்குவரத்தின் இடை நேரம் என்ன?

8. நாள்தோறும் கிராமத்தில் இருந்து பஸ்ஸில் பயணம் செய்வோர் எண்ணிக்கை என்ன?

9. அப்பயணிகளில் அங்காடி செல்வோர் எண்ணிக்கை என்ன?

10. மற்ற காரியங்களுக்காக செல்வோர் எண்ணிக்கை என்ன?

11. [illegible] மாட்டு வண்டியில் ஏற்றிச் செல்லும் பண்டங்களின் சதவிகிதம் என்ன?

12. அண்மையில் உள்ள அங்காடிக்கு பண்டங்களை ஏற்றிச் செல்ல எவ்வளவு நேரம் தேவை?

13. மாட்டு வண்டியில் பொருள்களை 1 கி.மீ. ஏற்றிச் செல்ல என்ன வாடகை?

14. லாரியில் பொருள்களை 1 கி.மீ. ஏற்றிச் செல்ல வாடகை என்ன?

நுட்ப தொழில் சார் கூறுகள்:

15. கிராமத்தில் உள்ள குழாய் கிணறுகள் எண்ணிக்கை என்ன?

16. மின் விசையால் இயங்கும் பம்பு செட்டுகள் எண்ணிக்கை என்ன?

17. டீசல் எஞ்சினால் இயங்கும் பம்பு செட்டுகள் எண்ணிக்கை என்ன?

18. கிராம வீடுகளில் மின்வசதியுள்ள வீடுகள் சதவிகிதம் என்ன?

19. கிராம வீடுகளில் பெட்ரோமாக்ஸ் விளக்கு வசதியுடைய வீடுகள் சதவிகிதம் என்ன?

20. எண்ணெய் அடுப்பு உபயோகிக்கும் வீடுகளின் சதவிகிதம் என்ன?

21. கிராமத்தில் உள்ள வானொலிகளின் எண்ணிக்கை என்ன?

22. கிராமத்தில் உள்ள சைகிள்கள் எத்தனை?

23. எத்தனை மோட்டார் சைகிள்கள் உள்ளன?

24. விவசாயிகளில் அதிக விளைச்சல் தரக்கூடிய விதைகளை உபயோகிப்போர் சதவிகிதம் என்ன?

25. விவசாயிகளில் ரசாயன உரம் உபயோகிப்போர் சதவிகிதம் என்ன?

26. ரசாயன உரம் வாங்க தலைநபர் செய்யும் செலவு என்ன?

27. நீர்பாசன வசதிகளை விவசாயிகளில் பயன்படுத்துவோர் சதவிகிதம் என்ன?

பொருளாதார கூறுகள்:

28. அரிசிக்காக குடும்பத்தில் செய்யும் செலவு.

29. மற்ற உணவு பண்டங்களுக்குச் செய்யும் செலவு.

30. உணவு சாராத செலவு.

31. குடும்பத்தின் அளவு.

Appendix 3

Sample villages

Chingleput District	Taluk
2. Rendenkattalai	Sriperumbudur
3. Ayyaprantangal	
4. Kannapalayam	
5. Samanthavada	Tiruttani
6. Mappedu	Tiruvallur
8. Tirukachur	Chingleput
9. Kalapakkam	
10. Vengadamangalam	
11. Kalivanthipattu	
12. Palayasivaram	Kanchipuram
North Arcot District	
15. Mamandur	Cheyyar
16. Pattu	Gudiyatham
17. Kilvaithinankuppam	
18. Navlock	Wallajahpet
19. Kodakkal	
21. Kathalambattu	Vellore
23. Pudurnadu	Tiruppattur
24. Madapalli	
25. C. Nammiandal	Chengam
26. Vinnavanur	
27. Kalpattu	Polur
28. Avaniyapuram	Wandiwash
29. Naruthodu	
South Arcot District	
30. Vanur	Tindivanam
31. Kambur	
32. Elayandapattu	
33. Kamandur	Gingee
34. Nagar	Villupuram
35. V.Ariyalur	
36. Panchamadur	
37. V.Agaram	
38. Kunniyur	Kallakurichi
39. Vilavandai	Tirukkoyilur
40. Kozhai	Chidambaram
41. Melmoongaladi	
42. Gundo-Uppalavadi	Cuddalore
43. A.Sittur	Vriddhachalam
Dharmapuri District	
46. Dalavahalli	Dharmapuri
50. Junjappalli	Krishnagiri
51. Ponneri	Harur

Sample villages (Continued)

Salem District	Taluk
52. Muthunaikenpatti	Omalur
53. Kadaiyampatti	
54. Mettupatti	Salem
55. Bailnadu	Rasipuram
56. Kakkaveri	
57. Komarapalayam	
59. Thamayanur	Attur
60. Thammampatti	
61. Kaveripatti Agraharam	Sankari
62. Kanagiri	
63. Musiri	Tiruchengode
Thanjavur District	
64. Thiruvalanjuli	Kumbakonum
65. Innambur	
66. Maharajapuram	
67. Chakkarapalli	Papanasam
68. Jambugurpuram	
69. Thiruvaduthurai	Mayuram
70. Parasalur	
71. Kottur	Mannargudi
72. Shenbagarayannallur	Thiruthuraipundi
73. Amur	Nagapattinam
74. Tirukudi	Nannilam
75. Seevathamangalam	
76. Puthambur	Arantangi
77. Ponnamangalam	
78. Tiruchitrambalam	Pattukkottai
79. Rajagiri	Thanjavur
80. Vilangudi	
81. Poyyandakkottai	Orathanad
Ramanathapuram District	
82. Thanichiyam	Mudukulathur
83. T. Punavasal	
84. Ariakudiputhur	Paramakudi
85. Terkutharavai	Ramanathapuram
86. Mayakulam	
87. Piranpatti	Tiruppattur
88. Elayiranpayai	Sattur
89. Lakshmipuram	
90. Palavanatham	Aruppukkottai
91. T. Vepankulam	
92. Ramachandrapuram	Srivilliputtur
93. Sethunarayanapuram	

Sample villages (Continued)

Tirunelveli District	Taluk
94. Kamanaikenpatti	Kovilpatti
95. Boothalapuram	
96. Poddapanaickenpatti	
97. Kannakkatti	
98. Vadakkupanavadalli	Sankaranayinarkoil
99. Nalumavadi	Tiruchendur
100. Palankulam	
101. Kuthapanjam	Ambasamudram
102. Sankarankulam	Nanguneri
103. Muthumothanmoli	
104. Inamkesavaneri	
Tiruchirappalli District	
110. Naduvallur	Musiri
111. Moovanur	
112. M.Puttur	
113. Allagarai	
114. Kannapadi	Perambalur
115. Andannallur	Tiruchirappalli
116. Sathanur	
117. Vellannur	Kulathur
118. Vellur	
119. Vandallaigudallur	Lalgudi
120. Lamballakudi	Tirumayam
121. Thennilai East	Karur
122. Punnam	
123. Thirukkampuliyur	Kulittalai
124. Thoppampatti	
Madurai District	
126. Mullipadi	Dindigul
127. Authur	
128. Melavalavur	Melur
129. Nadumandalam	
130. Karumattur	Thirumangalam
131. Thennanallur	
132. Nadakkottai	Nilakottai
133. Pannaipuram	Periyakulam
134. Koduvillarpatti	
135. Odaipatti	Palani
136. Porulur	
137. Kilakuchettipatti	Kodaikanal
Coimbatore District	
138. Tholampalayam	Avanashi
139. Nellthora	
140. Thekkalur	
141. Kalapathy	Coimbatore

Appendix 3

Sample villages (Continued)

Coimbatore District (Contd.)	Taluk
142. Elavanthi	Palladam
143. Arasur	
144. Mukasipudur	Erode
145. Kallipalayam	Dharapuram
146. Lakkamanaickenpatti	
147. Indiampalayam	Gobichettipalayam
148. Kolappalur	
149. Andiyur	Bhavani
Nilgiris District	
150. Ithalur	Ootacamund

Note: The code on the left refers to the location number on the maps showing village location. Those in the list above represent the villages which finally entered the analysis.

Appendix 4 **District -level topological nodal accessibility**

a. Chingleput

		1	2	3	4	5	6	7	8	9	10	11
1.	Proddaturpet	x										
2.	Tiruttani	1	x									
3.	Tiruvallur	2	1	x								
4.	Ponneri	3	2	1	x							
5.	Madras	3	2	1	1	x						
6	Arkonam	2	1	1	2	2	x					
7.	Kanchipuram	3	2	1	2	1	1	x				
8.	Uthiramerur	4	3	2	3	2	2	1	x			
9	Chingleput	4	3	2	2	1	2	1	1	x		
10.	Maduranthakam	5	4	3	3	2	3	2	1	1	x	
11.	Tirukkulikundram	5	4	2	2	1	3	2	2	1	1	x
	A_i	32	23	16	21	16	19	16	21	18	25	23

Total length of network 409 miles (650 kms). Length of shortest path 358 miles (572 kms).

Appendix 4 (Continued)

b. North Arcot

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Krishnagiri	x																		
2. Vaniyambadi	1	x																	
3. Jolarpet	1	1	x																
4. Tiruppattur	1	2	1	x															
5. Ambur	2	1	2	3	x														
6 Gudiyatham	3	2	3	4	1	x													
7. Polur	2	3	3	3	2	2	x												
8. Vellore	3	2	3	4	1	1	1	x											
9. Arni	4	3	4	5	2	2	1	1	x										
10. Tiruvannamalai	1	2	2	2	3	3	1	2	2	x									
11 Tirukkoyilur	2	3	3	3	4	4	2	3	3	1	x								
12 Arcot	4	3	4	5	2	2	2	1	1	3	4	x							
13. Walajahpet	5	4	5	6	3	3	3	2	2	4	5	1	x						
14 Sholingur	7	6	7	8	5	5	4	4	4	6	6	3	2	x					
15. Arkonam	6	5	6	7	4	4	3	3	3	5	5	2	1	1	x				
16. Tiruvaithipuram	5	4	5	5	3	3	2	2	1	3	4	2	2	3	2	x			
17. Kanchipuram	4	5	5	5	4	4	2	3	2	3	4	2	1	2	1	1	x		
18 Wandiwash	3	4	4	4	3	3	1	2	1	2	3	2	2	3	2	2	1	x	
19. Tindivanam	2	3	3	3	4	4	2	3	2	1	2	3	3	4	3	3	2	1	x
A_i	56	54	62	70	49	53	39	41	43	46	61	46	55	81	66	53	51	43	48

Total network length - 684 miles (1094 km); shortest path length - 628 miles (1004 km)

Appendix 4 (Continued)

c. South Arcot

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Tindivanam	x													
2.	Tiruvannamalai	1	x												
3.	Villupuram	1	2	x											
4.	Pondicherry	1	2	1	x										
5.	Tirukkoyilur	2	1	1	2	x									
6	Panruti	2	2	1	2	1	x								
7.	Nellikkuppam	3	3	2	2	2	1	x							
8.	Cuddalore	2	4	2	1	3	2	1	x						
9.	Kallakurichi	3	2	2	3	1	2	3	4	x					
10.	Vriddhachalam	4	3	3	4	2	3	4	3	1	x				
11.	Neyyveli	4	4	4	3	3	4	3	2	2	1	x			
12.	Kurinjipadi	3	5	3	2	4	3	2	1	3	2	1	x		
13.	Porto Novo	3	5	3	2	4	3	2	1	3	2	3	2	x	
14.	Chidambaram	4	4	4	3	3	4	3	2	2	1	2	1	1	x
	A_i	33	38	29	28	29	30	31	28	31	33	36	33	34	34

Total route length - 446 miles (714 km); shortest path length - 403 miles (645 km).

Appendix 4 (Continued)

d. Dharmapuri

		1	2	3	4	5	6	7
1.	Hosur	x						
2.	Denkanikkottai	1	x					
3.	Krishnagiri	1	2	x				
4.	Kaveripatnam	2	2	1	x			
5.	Palacode	1	1	2	1	x		
6	Dharmapuri	2	2	2	1	1	x	
7.	Harur	2	2	2	1	1	1	x
	A_i	9	10	10	8	7	9	9

Total route length - 277 miles (443 km)

Shortest path - 253 miles (405 km)

e. Nilgiris

		1	2	3	4	5	6	7	8
1.	Nelliyalam	x							
2.	Devarshola	1	x						
3.	Gudalur	1	1	x					
4.	O'Valley	2	2	1	x				
5.	Naduvattam	2	2	1	2	x			
6.	Ootacamund	3	3	2	3	1	x		
7.	Kotagiri	4	4	3	4	2	1	x	
8.	Coonoor	4	4	3	4	2	1	1	x
	A_i	17	17	12	18	12	14	19	19

Total route length - 76 miles (122km)

Shortest path - 60 miles (96 km)

Appendix 4 (Continued)

f. Salem

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Mettur	x												
2. Taramangalam	1	x											
3. Edapadi	1	2	x										
4. Salem	1	1	1	x									
5. Attur	2	2	2	1	x								
6. Mallasamudram	2	2	2	1	2	x							
7. Sankari	2	2	1	1	3	1	x						
8. Bhavani	2	3	1	2	3	2	1	x					
9. Pallipalayam	3	3	2	2	3	2	1	1	x				
10. Tiruchengode	4	4	3	3	4	3	1	2	1	x			
11. Rasipuram	2	2	3	1	1	1	2	3	3	1	x		
12. Namakkal	3	3	3	2	2	2	3	3	2	1	1	x	
13. Velur	4	4	4	3	3	3	3	3	2	1	2	1	x
A_i	27	29	25	19	28	23	21	26	25	28	23	26	33

Total route length - 418 miles (669 km)

Shortest path - 368 miles (589)

Appendix 4 (Continued)

g. Coimbatore

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Satyamangalam	x																					
2. Gobichettipalayam	1	x																				
3. Bhavani	1	1	x																			
4. Erode	2	1	1	x																		
5. Punjai Pugalur	1	1	2	2	x																	
6. Sirumugai	1	2	3	3	1	x																
7. Mettupalayam	2	3	4	4	2	1	x															
8. Karamadai	3	3	4	4	2	2	1	x														
9. Annur	2	2	3	3	1	1	2	1	x													
10. Coimbatore	3	3	2	2	2	2	2	1	1	x												
11. Sulur	4	3	3	3	3	3	3	2	2	1	x											
12. Vellaimpalayam	3	1	2	2	2	3	4	3	3	2	3	x										
13. Avanashi	2	1	1	1	1	2	4	3	2	1	3	1	x									
14. Tiruppur	4	1	1	1	3	4	5	4	4	3	2	1	2	x								
15. Kangayam	4	2	1	1	3	4	5	4	4	3	2	2	2	1	x							
16. Palladam	4	2	2	2	3	4	4	3	3	2	1	2	2	1	1	x						
17. Pollachi	3	3	3	3	3	3	3	2	2	1	2	3	3	2	2	1	x					
18. Anaimalai	4	4	4	4	4	4	4	3	3	2	3	4	4	3	3	2	1	x				
19. Valparai	4	4	4	4	4	4	4	3	3	2	3	4	4	3	3	2	1	1	x			
20. Udumalpet	5	3	3	3	4	4	4	3	3	2	1	3	3	2	3	1	1	1	2	x		
21. Dharampuram	4	3	3	2	4	4	4	3	3	2	2	4	4	3	2	1	1	2	2	1	x	
22. Vellakoil	3	3	2	1	4	5	5	4	4	3	3	3	3	2	1	2	2	3	3	2	1	x
Ai	59	47	50	49	53	61	69	58	49	42	52	53	51	55	56	48	45	63	64	57	57	60

Total route length - 978 miles (1565 km)

Shortest path - 881 miles (1410 km)

Appendix 4 (Continued)

h. Thanjavur

Total route length - 730 miles (1168 km)

Shortest path - 660 miles (1056 km)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Sirkali	x																					
2. Mayuram	1	x																				
3. Kuttalai	2	1	x																			
4. Tiruvidaimaradur	3	2	1	x																		
5. Kumbakonum	4	3	2	1	x																	
6. Papanasam	5	4	3	2	1	x																
7. Chakkarapalli	4	3	3	3	2	1	x															
8. Thanjavur	4	3	3	4	3	2	1	x														
9. Tiruvaiyuru	5	4	4	5	4	3	2	1	x													
10. Tirukkattuppalli	5	4	4	5	4	3	2	1	1	x												
11. Ammapet	3	2	2	2	2	1	2	1	2	2	x											
12. Mannargudi	4	3	3	2	2	1	2	1	2	2	2	x										
13. Koothanallur	3	2	2	1	1	1	2	2	3	3	2	1	x									
14 Tiruvarur	2	1	1	1	1	1	2	2	3	3	1	2	1	x								
15. Tranquebar	1	2	2	2	2	2	3	3	4	4	2	3	2	1	x							
16. Nagapattinam	2	2	2	2	2	2	3	3	4	4	2	3	2	1	1	x						
17. Thiruthuraipundi	3	2	2	2	2	2	3	2	3	3	2	1	2	1	2	1	x					
18. Vedaranayam	3	3	3	3	3	3	4	3	4	4	3	2	3	2	2	1	1	x				
19. Muthupet	4	3	3	3	3	3	4	3	4	4	3	2	3	2	3	2	1	1	x			
20. Adirampattinam	5	4	4	4	4	4	3	2	3	3	2	2	3	3	4	3	2	2	1	x		
21. Pattukkottai	4	3	3	3	3	3	2	1	2	2	1	1	2	2	3	2	1	2	2	1	x	
22. Arantangi	5	4	4	4	4	4	3	2	3	3	2	2	3	3	4	3	2	3	3	2	1	x
A_i	72	56	54	55	53	51	54	47	66	62	41	43	44	36	52	47	40	55	57	61	44	64

Appendix 4 (Continued)

i. Tiruchirappalli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Pallipatti	x													
2. Karur	1	x												
3. Punjai Pugalur	2	1	x											
4. Kulithalai	2	1	2	x										
5. Musiri	4	3	4	2	x									
6 Thattayangarpet	5	4	5	3	1	x								
7. Thuraiyur	4	3	4	2	1	1	x							
8. Perambalur	4	3	4	2	2	2	1	x						
9. Ariyalur	5	4	5	3	3	3	2	1	x					
10. Kalagudi	5	4	5	3	3	3	2	1	1	x				
11. Lalgudi	4	3	4	2	2	3	2	2	2	1	x			
12. Tiruchirappalli	3	2	3	1	1	2	1	1	2	2	1	x		
13. Manaparai	4	3	4	2	2	3	2	2	3	3	2	1	x	
14. Pudukkottai	4	3	4	2	2	3	2	2	3	3	2	1	1	x
A_i	47	35	47	27	30	38	27	27	37	36	30	21	32	32

Total route length - 439 miles (702 km)
Shortest path - 398 miles (637 km)

Appendix 4 (Continued)

j. Madurai

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Palani	x																	
2. Dindigul	1	x																
3. Kodaikanal	4	3	x															
4. Ballagundu	3	2	1	x														
5. Nilakkottai	2	1	2	1	x													
6. Nattam	2	1	4	3	2	x												
7. Bodinayyakkannur	6	5	4	3	4	5	x											
8. Allinagaram	5	4	3	2	3	4	1	x										
9. Periyakulam	4	3	2	1	2	4	2	1	x									
10. Andipatti	4	3	2	1	2	3	2	1	1	x								
11. Usilampatti	4	3	2	1	2	2	3	2	2	1	x							
12. Madurai	3	2	3	2	1	1	4	3	3	2	1	x						
13. Melur	3	2	4	3	2	1	5	4	4	3	2	1	x					
14 Tirumangalam	3	2	3	2	1	2	4	3	3	2	1	1	2	x				
15. Chinnamanur	6	5	4	3	4	5	2	1	2	2	3	4	5	4	x			
16. Cumbum	8	7	6	5	6	7	4	3	4	4	5	6	7	6	2	x		
17. Gudalur	9	8	7	6	5	8	5	4	5	5	6	7	8	7	3	2	x	
18. Uthampalayam	7	6	5	4	5	6	3	2	3	3	4	5	6	5	1	1	2	x
A_i	74	58	59	43	47	60	62	46	46	41	44	49	62	51	56	83	97	68

Total route length -392 miles (672 km)
Shortest path - 354 miles (566km)

Appendix 4 (Continued)

k	Ramanathapuram	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1.	Tirupattur	x																				
2	Karaikudi	1	x																			
3.	Devakkottai	2	1	x																		
4.	Sivaganga	1	1	1	x																	
5.	Tiruppuvanam	2	2	2	1	x																
6.	Madurai	3	3	3	2	1	x															
7.	Ilyangudi	2	2	2	1	2	3	x														
8.	Mannamadurai	2	2	2	1	1	2	2	x													
9.	Virudhunagar	4	4	4	3	2	1	4	2	x												
10.	Srivilliputtur	4	4	4	3	2	1	4	4	2	x											
11.	Rajapalayam	5	5	5	4	3	2	5	5	3	1	x										
12.	Tiruthangal	5	5	5	4	3	2	5	3	1	1	2	x									
13.	Sivakasi	6	6	6	5	4	3	6	4	2	2	3	1	x								
14.	Sattur	5	5	5	4	3	2	5	3	1	3	4	2	1	x							
15.	Ettaiyapuram	4	4	4	3	2	3	4	2	2	4	5	3	2	1	x						
16.	Aruppukkottai	3	3	3	2	1	2	3	1	1	3	4	2	3	2	1	x					
17.	Kamuthi	3	3	3	2	2	3	2	1	2	4	5	3	4	3	2	1	x				
18.	Paramakudi	3	3	3	2	2	3	1	1	3	5	6	4	5	4	3	2	1	x			
19.	Ramanathapuram	3	2	1	2	3	4	2	2	4	6	7	5	6	5	4	3	2	1	x		
20.	Kilakarai	4	3	2	3	3	4	3	2	3	5	6	4	5	4	3	2	1	2	1	x	
21.	Rameshwaram	4	3	2	3	4	5	3	3	4	7	8	6	7	6	5	4	3	2	1	2	x

Total route length - 662 miles (1059 km)
Sortest path - 599 miles (958 km)

Appendix 4 (Continued)

1. Tirunelveli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Puliangudi	x																					
2. Sankaranayankoil	1	x																				
3. Kovilpatti	2	1	x																			
4. Ettaiyapuram	3	2	1	x																		
5. Kadayannallur	1	1	2	3	x																	
6. Tankasi	2	2	2	3	1	x																
7. Shencottah	3	3	3	4	2	1	x															
8. Vikramasinghapuram	3	3	3	4	2	1	2	x														
9. Ambasamudram	4	2	2	3	3	2	3	1	x													
10. Manimathur	5	3	3	4	4	3	4	2	1	x												
11. Tirunelveli	2	1	1	2	2	1	2	2	1	2	x											
12. Srivaikuntam	3	2	2	3	3	2	3	3	2	3	1	x										
13. Tuticorin	3	2	2	1	3	2	3	3	2	3	1	2	x									
14. Sayarpuram	4	3	3	2	4	3	4	4	3	4	2	1	1	x								
15. Kayalpattinam	4	3	3	2	4	3	4	4	3	4	2	3	1	2	x							
16. Nazareth	3	2	2	3	3	2	3	3	2	3	1	2	2	3	1	x						
17. Sattankulam	3	2	2	3	3	2	3	3	2	3	1	2	2	3	2	1	x					
18. Tiruchendur	4	3	3	3	4	3	4	4	3	4	2	3	2	3	1	2	1	x				
19. Kulasekharanpur	4	3	3	4	4	3	4	4	3	4	2	3	3	4	2	1	1	1	x			
20. Tisayanilai	4	3	3	4	4	3	4	4	3	4	2	3	3	4	3	2	1	2	1	x		
21. Eruvadi	3	2	2	3	3	2	3	3	2	3	1	2	2	3	3	2	1	2	2	1	x	
22. Veerananallur	3	2	2	3	3	2	3	2	1	2	1	2	2	3	3	2	2	3	3	2	1	x

Total route length - 558 miles (893 kms)
Shortest path - 500 miles (800 kms)

Appendix 4 (Continued)

m. Kanyakumari

		1	2	3	4	5
1.	Kuzhiturai	x				
2.	Padmanabhapuram	1	x			
3.	Colachel	2	1	x		
4.	Nagercoil	2	1	1	x	
5.	Kanyakumari	3	2	2	1	x

Total route length - 50 miles (80 kms)

Shortest path - 47 miles (75 kms)

Appendix 5 Topological accessibility: State matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Madras	x																								
Kanchipuram	1	x																							
Vellore	1	1	x																						
Gudiyatham	2	2	1	x																					
Ambur	2	2	1	1	x																				
Vaniyambadi	3	3	2	2	1	x																			
Tiruvannamalai	2	2	1	2	2	3	x																		
Villupuram	1	2	2	3	3	4	1	x																	
Pondicherry	1	3	3	4	4	5	2	1	x																
Cuddalore	2	3	2	3	3	4	1	1	1	x															
Neyyveli	3	4	3	4	4	5	2	1	2	1	x														
Salem	2	3	3	3	2	1	2	1	2	1	1	x													
Erode	3	4	4	4	3	2	3	2	3	2	2	1	x												
Coimbatore	4	5	5	5	4	3	4	3	4	3	3	2	1	x											
Ootacamund	5	6	6	6	5	4	5	4	5	4	4	3	2	1	x										
Tiruppur	4	5	5	5	4	3	4	3	4	3	3	2	1	1	2	x									
Karur	3	4	4	4	3	2	3	2	3	2	2	1	1	1	2	2	x								
Pollachi	5	6	6	6	5	4	5	4	5	4	4	3	2	1	2	2	2	x							
Valparai	6	7	7	7	6	5	6	5	6	5	5	4	3	2	3	3	3	1	x						
Dindigul	3	4	4	5	4	3	3	2	3	2	2	2	2	2	3	3	1	1	2	x					
Tiruchirappalli	2	3	3	4	3	2	2	1	2	1	1	1	2	2	3	3	1	2	3	1	x				
Thanjavur	3	4	4	5	4	3	3	2	3	2	2	2	3	3	4	4	2	3	4	2	1	x			
Kumbakonum	4	5	5	6	5	4	4	3	3	2	3	3	4	4	5	5	3	4	5	3	2	1	x		
Mayuram	4	5	5	6	6	5	4	2	2	1	2	2	3	4	5	4	3	5	6	3	2	2	1	x	
Nagapattinam	5	6	6	6	5	4	4	3	3	2	3	3	4	4	5	5	3	4	5	3	2	1	2	1	x
Pattukkottai	3	4	4	5	4	3	3	2	3	2	2	2	3	3	4	4	2	3	4	2	1	1	2	3	2
Madurai	4	5	5	6	5	4	4	3	4	3	3	3	3	3	4	4	2	2	3	1	2	2	3	4	3
Bodiyanayakanur	5	6	6	7	6	5	5	4	5	4	4	3	2	3	3	3	3	1	2	2	3	3	4	5	4
Virudhunagar	5	6	6	7	6	5	5	4	5	4	4	4	4	4	5	5	3	3	4	2	3	3	4	5	4
Srivillipputtur	5	6	6	7	6	5	5	4	5	4	4	4	4	4	5	5	3	3	4	2	3	3	4	5	4
Rajapalayam	6	7	7	8	7	6	6	5	6	5	5	5	5	5	6	6	4	4	5	3	4	4	5	6	5
Kadayanallur	7	8	8	9	8	7	7	6	7	6	6	6	6	6	7	7	5	5	6	4	5	5	6	7	6
Tirunelveli	6	7	7	8	7	6	6	5	6	5	5	5	5	5	6	6	4	4	5	3	4	4	5	6	5
Aruppukottai	6	7	7	8	7	6	6	5	6	5	5	5	5	5	6	6	4	4	5	3	4	4	5	6	5
Tuticorin	7	8	8	9	8	7	7	6	7	6	6	6	6	6	7	7	5	5	6	4	5	5	6	7	6
Nagercoil	7	8	8	9	8	7	7	6	7	6	6	6	6	6	7	7	5	5	6	4	5	5	6	7	6

Appendix 5 (Contd)

	26	27	28	29	30	31	32	33	34	35	36
Madurai	1	x									
Bodinayakanur	2	1	x								
Virudhunagar	2	1	2	x							
Srivillipittur	2	1	2	1	x						
Rajapalayam	3	2	3	2	1	x					
Kadayanallur	4	3	4	3	2	1	x				
Tirunelveli	3	2	3	1	2	2	1	x			
Aruppukottai	3	2	3	1	2	3	3	2	x		
Tuticorin	4	3	4	2	3	3	2	1	3	x	
Nagercoil	4	3	4	2	3	3	2	1	3	2	x

v = 36

e = 62

d = 9

Appendix 6 Metricated accessibility matrix: State level

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1
1	Madras	x															
2	Kanchipuram	43	x														
3	Vellore	85	45	x													
4	Gudiyatham	108	68	23	x												
5	Ambur	118	78	33	16	x											
6	Vaniyambadi	130	90	45	28	12	x										
7	Tiruvannamalai	137	97	52	75	85	97	x									
8	Villupuram	95	93	102	125	135	147	50	x								
9	Pondicherry	100	143	140	163	173	185	88	38	x							
10	Cuddalore	112	155	142	139	149	161	64	40	12	x						
11	Neyyveli	142	185	164	189	202	190	114	62	42	30	x					
12	Salem	203	190	145	128	112	100	158	108	146	125	90	x				
13	Erode	239	226	181	164	148	136	194	144	182	161	126	36	x			
14	Coimbatore	299	286	241	224	208	196	254	204	242	221	186	96	60	x		
15	Ootacamund	329	326	281	264	248	236	294	244	282	261	226	136	100	40	x	
16	Tiruppur	275	262	217	200	184	172	230	180	218	197	162	72	36	30	70	
17	Karur	263	250	205	188	172	160	218	168	206	157	186	61	40	83	123	11
18	Pollachi	323	310	265	248	232	222	278	228	266	245	210	160	84	24	64	5
19	Valparai	348	335	290	273	257	245	303	253	291	270	235	185	119	49	89	7
20	Dindigul	255	298	253	236	220	208	210	160	187	175	140	108	88	94	134	12
21	Tiruchirappalli	195	238	192	230	214	202	150	100	127	115	80	83	82	125	165	15
22	Thanjavur	230	273	227	265	249	237	185	135	106	94	105	118	117	160	200	19
23	Kumbakonum	182	225	251	289	273	261	134	160	82	70	100	142	141	184	224	21
24	Mayuram	162	205	247	270	254	242	114	140	62	50	80	162	161	204	244	23
25	Nagapattinam	222	265	287	310	294	282	154	180	102	90	120	166	165	208	248	23
26	Pudukkottai	232	275	222	260	244	232	180	130	144	108	110	113	112	190	230	22
27	Madurai	295	338	293	276	260	248	250	200	204	168	120	148	128	134	174	16
28	Bodinayakanur	351	394	340	323	307	295	210	256	260	224	176	204	159	99	139	12
29	Virudhunagar	325	368	323	306	290	278	280	230	234	198	150	178	158	164	204	19
30	Srivilliputtur	345	388	343	326	310	298	300	250	254	218	170	198	178	184	224	21
31	Rajapalayam	352	395	350	333	317	305	307	257	261	225	178	205	185	191	231	22
32	Kadayanallur	382	425	380	363	347	335	337	287	291	255	207	235	215	121	161	25
33	Tirunelveli	390	433	388	371	355	343	345	295	299	263	215	243	223	229	249	25
34	Aruppukkottai	337	380	335	318	302	290	292	242	246	210	262	190	170	176	216	20
35	Tuticorin	423	466	421	404	388	376	378	328	332	296	246	276	256	262	302	29
36	Nagercoil	447	490	478	428	412	400	402	352	356	320	272	300	280	286	326	31
		8484	9038	7986	7931	7598	7384	7016	6118	6464	5720	5472	5320	5194	5954	7294	687
	$\bar{x}$	236	251	222	220	211	205	195	170	180	159	152	148	144	165	203	17

Appendix 6 (Contd)

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
18	107	x																		
19	132	25	x																	
20	48	70	95	x																
21	42	130	155	60	x															
22	77	165	190	95	35	x														
23	101	189	214	119	59	24	x													
24	121	209	234	139	79	44	20	x												
25	125	213	238	143	83	48	60	40	x											
26	72	160	185	90	30	38	62	82	86	x										
27	88	110	135	40	100	98	122	142	146	60	x									
28	144	75	100	96	156	154	178	198	202	116	56	x								
29	118	140	165	70	130	128	152	172	176	90	30	86	x							
30	138	160	185	90	150	148	172	192	196	110	50	106	44	x						
31	145	167	192	97	157	155	179	199	203	117	57	113	51	7	x					
32	175	197	222	117	177	175	199	219	223	137	87	143	81	37	30	x				
33	183	205	230	135	195	193	217	237	241	155	95	151	65	80	43	43	x			
34	130	152	187	92	152	150	174	194	198	112	42	98	12	56	63	93	77	x		
35	116	138	163	68	128	126	150	170	174	88	128	184	98	142	76	76	33	110	x	
36	240	262	287	192	252	250	274	294	298	212	152	208	122	166	130	100	57	137	90	x
	4895	6087	6955	4746	4723	5449	5593	5816	6424	5004	5138	6430	5810	6429	6494	7123	7533	6398	7748	9585
$\bar{X}$	136	169	193	132	131	151	155	162	178	139	14[illegible]	179	161	179	180	198	209	178	215	262

Distances are in miles.

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